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ON SOME FEMALES OF *TROIDES* (LEPIDOPTERA) WITH MALE COLOURATION

Dr. KARL JORDAN, F.R.S., F.R.E.S.

IN many species of Lepidoptera the sexes are similar in colouration, in others they differ more or less considerably, and in others again the female is di- or polymorphic, one of the forms resembling the male or being intermediate between the sexes. The last category of sex-linked colouring is the most interesting, occurring among Lepidoptera only in the female, evidently never in the male, no species being known in which the male is dimorphic and the female monomorphic. As examples the well-known *Papilio polytes* L. 1758 and *Morpho cypris* Westw. 1851 may be mentioned, where one form of the female combines the female sex with the male colour. Such combinations are the product of the phylogenetic development of the species, their evolution being explainable on Darwinian principles. These phylogenetic intersexes or viragos have quite a different status in nature from the individual intersexes and gynandromorphs which are the product of an accident in the ontogenetic development of the specimen, the accident having occurred in the germ-cell or later in the individual life, either in male or female, ontogenetic intersexes being either males with the addition of female colouration, or females with the addition of male colouration, and the mixture of male and female colouring being as haphazard as are accidents.

I exhibit a female each of three species of *Troides*, generally known as *Ornithoptera* (a name which could only be rendered valid under suspension of the Code of Rules), illustrating intersexuality in very different degrees.

1. *Triodes priamus poseidon* Doubl. 1847.

A number of females are known in which there is metallic green scaling in the cell of the fore-wing, the green scales having the same structure as in the male. As they are apparently always found at the proximal side of the dirty white cell-patch or at its proximal and distal sides, occasionally extending to other parts of the wings, there is method in this development, and I therefore look upon the green patch as indicating an attempt by nature to produce dimorphism. Such specimens, I think, are not ontogenetic intersexes.

2. *Troides priamus urvillianus* Guérin 1829.

A true intersex; a mixture of male and female colouration. In wing-shape intermediate between the sexes. Fore-tarsus and genitalia female. Thorax above with blue stripe as in male; red colouring on breast somewhat reduced, but not so much as in male. Abdomen nearly as yellow as in male, scales of upperside pointed, not dentate as in female, but broader than in male, intermediate; black markings of underside as small as in male. Left anal valve smaller than right one.

Wings above darker than in female, the dark ground being a mixture of male and female colouring, but the scales all multidentate as in female; on fore-wing in subcostal area vestiges of blue streaks which correspond to the blue stripe of male, the blue scales being entire as in male; the female markings on disk and in cell almost completely suppressed (the male has no such markings). Hind-wing as in normal female, but basal half mottled with black.

On underside the dark ground of fore-wing more uniformly black than above; cell-patch distinct but small; discal markings almost as in normal female. Hind-wing: outer half almost normal except that the dark markings are blacker; proximal half irregularly mottled with black; near base and at proximal side of black subcostal spot some pale blue scaling, but these scales not entire as the metallic blue scales of male, but dentate like the white scales of female in the same places.

A combination of male and female *T. p. urvillianus*, no hybridisation with another species indicated.

3. *Troides victoriae regis* ♀-intersex *ponceleti* Rothsch. 1936.

Wing-shape intermediate between the sexes, right and left sides not quite alike, the wings evidently not fully expanded. Fore-tarsus, anal valves and external genitalia feminine, but the ridges of the genital armature apparently somewhat enlarged. Neuration female. No band on fore-wing and no fringe of long hairs below abdominal margin of hind-wing. Scaling on upperside of abdomen nearly as in male; underside of abdomen with narrow black median stripe as in male, the black transverse bands of female absent.

Wings above and below with brilliant metallic golden green colouring, absent from normal female; ground-colour as deep velvety black as in male; on upper-side of fore-wing the black scaling entire as in male, on hind-wing and on under-side of both wings less modified than in male, but very different from the multidentate scaling of female. Fore-wing above: at base a large patch, bluish in cell as in male, and golden green between cell and hind-margin, towards apex of cell a large irregular metallic patch corresponding to the white cell-patch of female and connected with basal patch along median vein; a metallic subapical area corresponding to that of male, but including two discal and one submarginal golden spot homologous to spots of female, on disc one small metallic spot. Hind-wing: a series of discal patches as in female, but reduced and golden yellow, and some golden submarginal dots margined with golden green, such metallic scaling also at proximal and distal sides of discal patches, along veins in cell and between cell and costal margin; the golden scaling has preserved some dentition of the normal female patches, and on left hind-wing the patches contain some whitish scaling with more distinct dentition.

On underside the metallic patches of fore-wing more male-like in extent than above, especially in cell and on disc; on hind-wing the metallic markings more sharply defined, particularly in proximal half.

The green and the blue scales are entire as in male on upper- and under-side. The specimen is primarily a female, the male colouration being added secondarily. There is no trace of hybridisation with *Troides priamus urvillianus*; a hybrid probably would be more or less like *Troides allottei* Rothsch. 1914, which is intermediate, at least in neuration, and which the collector of it took to be a hybrid.

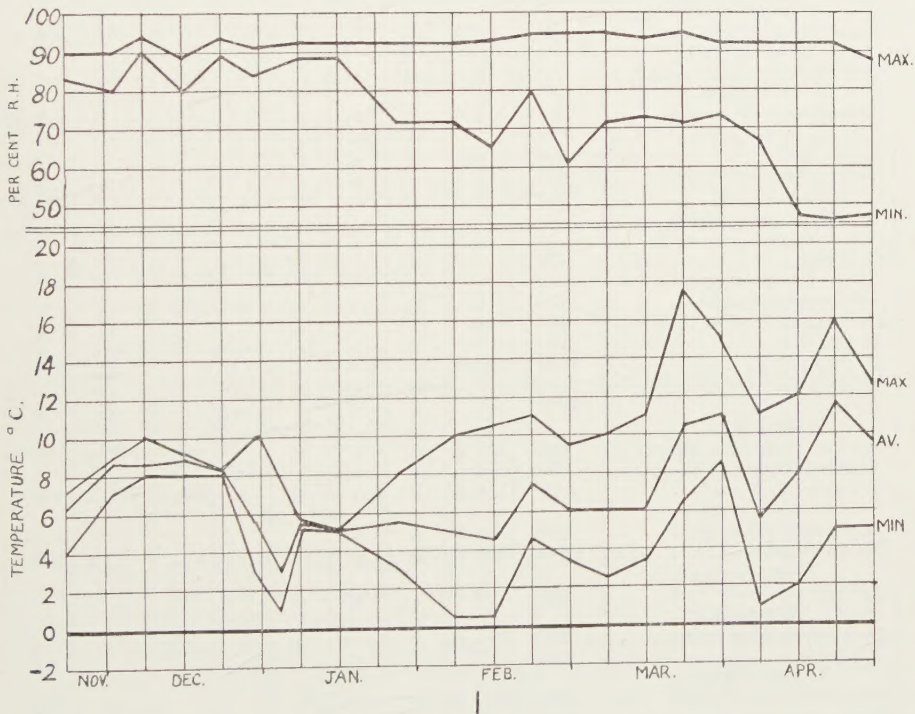
A NOTE ON THE RESISTANCE TO PROLONGED COLD OF SOME INSECT PESTS OF STORED PRODUCTS

By G. H. MANSBRIDGE, M.A., F.R.E.S.

(Imperial College of Science and Technology, Biological Field Station, Slough.)

DURING the winters 1934-5 and 1935-6, cultures of various insect pests of stored products were left in an unheated building to ascertain their resistance to an English winter under conditions comparable to those of a warehouse.

A recording thermo-hygrograph was kept with the cultures, and from this the average, maximum and minimum temperatures have been taken weekly and plotted on the graphs. The humidity was registered with a bimetallic coil thermometer which was kept moist with a wet wick. But since there was no arrangement for circulating the air, the humidity recorded is, generally, too high. The temperature recorded is correct to $\pm 1^{\circ}\text{C}$.



During the winter 1934-5 (graph 1) the temperature in the building at no time fell as low as 0°C ., while during the winter 1935-6 (graph 2) there were three separate weeks when the temperature was below 0°C ., and during these weeks the temperature was below 0°C ., for periods, on eleven days; including two days continuously below 0°C . at the end of December. During the winter 1934-5 the insects were not examined, but a final examination of all the

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TABLE I, SHOWING A LIST OF SPECIES WITH THE EFFECT OF LOW TEMPERATURES DURING THE WINTERS 1935-6 AND 1934-5.

	Approx. no.	Stage.	1935-6.					1934-5. July 1.	Con- trols.
			Nov. 19.	Jan. 1.	Feb. 19.	Apr. 20.	July 1.		
Lepidoptera.									
PHYCITIDAE.									
<i>Ephestia cautella</i> Wlk.	300	L	a	a	d			e	e
<i>E. elutella</i> Hb.	300	L	a	a	a	a	e	e	e
<i>E. kühniella</i> Zell.	500	L	a	a	a	a	e	e	e
<i>Plodia interpunctella</i> Hb.	300	L	a	a	a	a	e	e	e
GALERIIDAE.									
<i>Achroia grisella</i> F.	200	L	a	a	a		e	e	e
<i>Corcyra cephalonica</i> Stt.	200	L	a	?	d				
GELECHIIDAE.									
<i>Sitotroga cerealella</i> Ol.	100	L	a	?	?	?	d		e
TINEIDAE.									
<i>Borkhausenia pseudospretella</i> Stt.	100	L	a	a	a	a*			
<i>Tineola biselliella</i> L.	100	L	a	a	a	a	e	e	e
Coleoptera.									
NITIDULIDAE.									
<i>Carpophilus dimidiatus</i> F.	200	L & A	a	d				d	e & a
TROGOSITIDAE.									
<i>Tenebroides mauritanicus</i> L.	20	L	a	a	a	a	e	e	e
CURCULIONIDAE.									
<i>Ahasuerus advena</i> Waltl.	500	L & A	a	a	d				e & d
<i>Laemophloeus turcicus</i> G.	500	L	a	a	a	a	e	e	e
<i>L. turcicus</i>	500	A	a	a	d				a
<i>Oryzaephilus mercator</i> F.	500	L & A	a	a	d				e & a
<i>O. surinamensis</i> L.	500	L & A	a	a	a	d			e & a
CRYPTOPHAGIDAE.									
<i>Cryptophagus scanicus</i> L.	50	A	a	a	a*				a
<i>C. affinis</i>	20	A	a	a	a*				a
DERMESTIDAE.									
<i>Anthrenus verbasci</i> L.	100	L	a	a	a	a	e		e
<i>Dermestes lardarius</i> L.	500	L	a	a	d			e	e
<i>D. lardarius</i>	200	A	a	a	a	a	a	a	a
<i>D. vulpinus</i> F.	1000	L & A	a	d				d	e & a
<i>Trogoderma granarium</i> Er.	1000	L	a	a	a	a	a	a	a
<i>T. versicolor</i> K.	2000	L	a	a	a	a	a	a	a
PTINIDAE.									
<i>Gibbium psyllodes</i> Czemp.	500	L & A	a	a	a	a	e & a	e & a	e & a
<i>Niptus hololeucus</i> Fald.	10	A	a	a	a	a*			a
<i>Ptinus tectus</i> Boield.	1000	L & A	a	a	a	a	e & a	e & a	e & a
ANOBIIDAE.									
<i>Lasioderma serricorne</i> F.	500	L & A	a	a	d				e & a
<i>Sitodrepa panicea</i> L.	500	L & A	a	a	d			e & a	e & a
BOSTRYCHIDAE.									
<i>Rhizopertha dominica</i> F.	500	A	a	a	d				
LARIIDAE.									
<i>Bruchidius obtectus</i> Say.	200	L	?	?	?	?	d		e
<i>B. obtectus</i>	200	A	a	d					d
TENEBRIONIDAE.									
<i>Gnathocerus cornutus</i> F.	500	L & A	a	d				d	e & a
<i>Tenebrio molitor</i> L.	5000	L	a	a	a	a	e	e	e
<i>T. obscurus</i> F.	5000	L	a	a	a	a	e	e	e
<i>Tribolium castaneum</i> Hb.	2000	L & A	a	d				d	e & a
<i>T. confusum</i> Duv.	2000	L & A	a	d				d	e & a
ANTHRIBIDAE.									
<i>Araecerus fasciculatus</i> de G.	100	A	a	d				d	d
<i>A. fasciculatus</i>	100	L	a				d	d	e
CURCULIONIDAE.									
<i>Sitophilus granarius</i> L.	5000	A	a	a	a	d		a	a
<i>S. oryzae</i> L.	5000	A	a	a	d			d	a
<i>Caulophilus latinasus</i> Say.	100	A	a	a	d			d	a

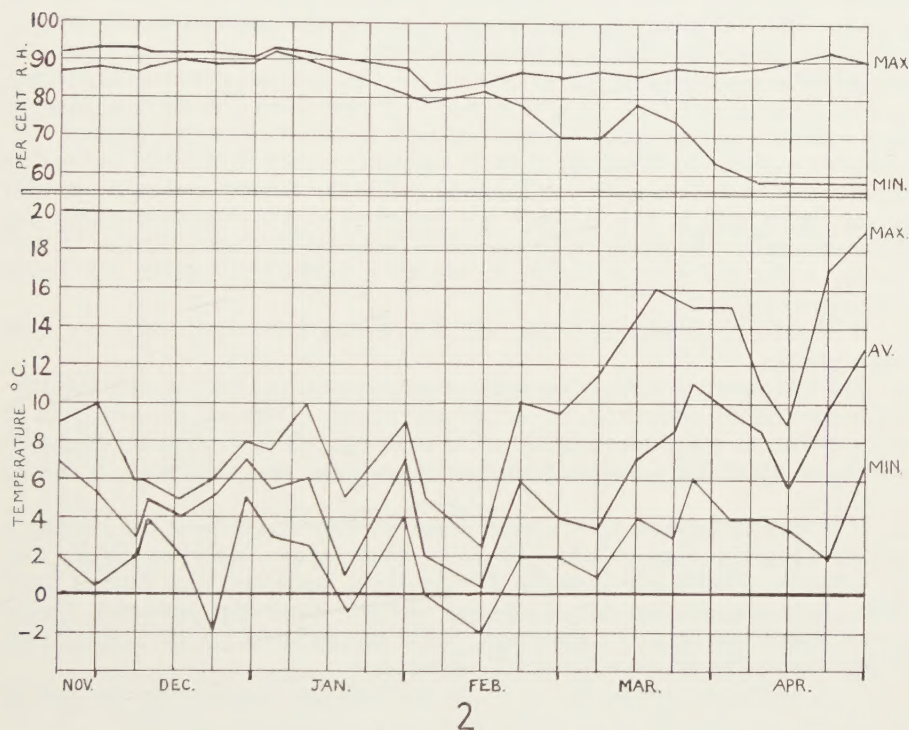
L = larvae, A = adults; indicating the stages to which the results refer.

a = alive, d = all dead, e = emerged; indicating the condition of the insects at various times.

* Cultures removed to other conditions, they continue to be alive and healthy.

cultures was made the following summer (July 1935). This examination showed that three species of insects survived the winter 1934-5 which were killed by the greater cold of the winter 1935-6. These insects are *Ephestia cautella*, *Sitodrepa panicea* and *Sitophilus granarius* (table 1).

For the winter 1935-6 the insects were examined on 19th November, 1st January, 19th February, 20th April, and 1st July. From the table it will be seen that *Oryzaephilus surinamensis* and *Sitophilus granarius* survived at least until February but were found dead in April. It is suggested that the cold at the beginning of April, although not very severe, killed these two species after they had started to lose their "cold-hardiness" during the warmer days of March.



During April 1936 mites were found infesting every culture; by July they were so bad that all the cultures were thrown out. For this reason it is not certain whether there were any larvae or pupae which would have emerged from the cultures of grain-feeding insects, i.e. *Sitotroga cerealella*, *Araecerus fasciculatus*, *Bruchidius obtectus*, *Rhizopertha dominica*, *Sitophilus granarius* and *S. oryzae*. By 1st July the temperature had been high for several weeks so that these insects would almost certainly have emerged had they been alive.

Controls were kept in the form of similar cultures in a heated insectary (12°-22° C.). In all cases the control cultures developed well and there was no parasitism. But in the cultures of *Plodia interpunctella* and *Tribolium* spp. there were some diseased larvae, amounting to less than 5% in each case. As a check on possible death from old age in the adults, counted specimens of

each species were also kept in separate containers in the heated insectary. The condition of these after the winter is shown in the column under "controls" on the table. In *Bruchidius obtectus* and some other beetles the control adults died before the end of the winter, so that in these cases it is not possible to judge the effect of the cold.

It is natural that some stages would be more susceptible to cold than others, so that survival would depend on the presence of the more resistant stages. This is illustrated by *Dermestes lardarius* in which the adults survive the winter but the larvae are killed. In *Laemophloeus turcicus* it is the larvae which survive the winter and the adults which are killed.

It is interesting to notice in *Dermestes* that *D. lardarius* survived both winters, but only the adult, while *D. vulpinus* were killed early in the winter. This difference in resistance in closely related species is also seen in *Sitophilus granarius* and *S. oryzae*; *Ephestia cautella* and *E. elutella* and *Oryzaephilus mercator* and *O. surinamensis*. The difference in closely related species is probably related to a difference in geographical distribution, since in each case the species more resistant to cold is found in colder regions. *D. lardarius* is native to England, while *D. vulpinus* is only found wild in warmer countries, *E. elutella* is native to England, while the related species *E. cautella* is not found wild in this country but is native in the countries round the Mediterranean. Similarly, *S. granarius* is found in the north of the United States, while the related species *S. oryzae* is only abundant in the south (Robinson, 1926).

It should be emphasised that all the species here dealt with are now cosmopolitan.

The resistance to cold is probably a large factor in determining the prevalence of these insects and, as one would expect, nearly all the survivors in this experiment are common pests in this country; while the remaining species which are killed have seldom become serious pests, and then only in heated buildings.

It is seen that under natural conditions the following insects can survive a winter when the temperature falls 2° C. below zero: *Ephestia elutella* and *E. kuhniella*, *Plodia interpunctella*, *Borkhausenia pseudospretella*, *Tineola biselliella*, *Laemophloeus turcicus*, *Anthrenus verbasci*, *Dermestes lardarius*, *Trogoderma granarium* and *T. versicolor*, *Gibbium psylloides*, *Niptus hololeucus*, *Ptinus tectus*, *Tenebrio molitor* and *T. obscurus*.

I am most grateful to Mr. G. V. B. Herford for keeping the readings of the thermo-hygrograph, from which are constructed the two graphs.

REFERENCE.

- ROBINSON, W., 1926, Low temperature and moisture as factors in the ecology of the rice weevil (*Sitophilus oryzae* L.) and the granary weevil (*Sitophilus granarius* L.). *Tech. Bull. Univ. Minnesota agr. Expt. Sta.*, 41.

THE GEOGRAPHICAL DISTRIBUTION OF *TYMPANOPHORA* WHITE

By FRIEDRICH E. ZEUNER.

SINCE the completion of my paper on the Recent and Fossil *TYMPANOPHORINAE* (1936, *Trans. R. ent. Soc. Lond.* **85** : 287) I have had an opportunity of studying the eight specimens of *Tympanophora* White contained in Brunner von Wattenwyl's collection and preserved in the Natural History Museum in Vienna. These are most probably the specimens on which Brunner's description in 1893, *Ann. Mus. civ. Stor. nat. Genova*, **33**, was based.

These eight specimens provide valuable fresh information concerning the geographical distribution of the genus. The localities, as given on the labels, are as follows :—

T. uvarovi Zeuner :

Fidji, Dämel leg. (Nr. 3915, adult male).

Tympanophora sp. :

North Australia, Dämel leg. (Nr. 3785, large male larva ; Nr. 3786, large female larva ; and one smaller female larva).

New South Wales (Nr. 498, ? adult female or large larva).

Sidney, Dämel leg. (two very small larvae, one of them Nr. 3870).

New Zealand, Deyrolle leg. (Nr. 4755, adult female).

This list shows that the genus is not restricted to the west and the east of the continent, but also occurs in the north, and even on the Fiji islands which lie on the extreme north-eastern edge of the Australian shelf. It is thus quite likely that it will be found in many other places on the Australian continent and islands, perhaps even in New Zealand.

The only adult male (from the Fiji islands) is *T. uvarovi* Zeuner, and not *T. pellucida* White. This species is typical of the eastern portion of the Australian continent. The remaining 7 specimens cannot be attributed to either of the species. The north Australian specimens are not adult. The female from "New South Wales" is, in every respect, identical with the type of *T. pellucida* from south-eastern Australia. The femoral stigma is visible, and the lengths of the ovipositor and the legs are exactly the same as in that species. Thus, females of the *pellucida*-type do occur in the area of distribution of *uvarovi*. The female labelled "New Holland" is the most interesting of all. Unfortunately, the exact locality where it was caught is unknown. In size and characters of body and legs it is identical with *pellucida* (also in the visible femoral stigma), but its ovipositor is much longer (33 mm. as compared with 26 mm.). It may represent a new species, or only a geographical subspecies. Furthermore, it is not quite certain whether the females under consideration are really adult, though I am inclined to believe they are. At any rate, the females of *Tympanophora* are hardly distinguishable, and much more material is needed to clear up the question of what the female of *T. uvarovi* is like, and how many other species there are in Australia.

NOTES ON THE HABITS OF *VESPA VULGARIS* AND *V. GERMANICA* (HYMENOPTERA)

By R. G. C. C. SANDEMAN, F.R.E.S.

For many years past I have been interested in the British Social Wasps, and more especially the common ground wasps *Vespa vulgaris* and *V. germanica*. I am firmly convinced that each species has distinctive habits, characteristics, peculiarities, and behaviour, which, whilst difficult to describe in words, nevertheless are constant and well known to those who study or observe closely wasps in the field and not as museum specimens alone.

Both species are common in the district of Crickhowell, Breconshire, where the observations here dealt with were made.

Nesting.

Vespa vulgaris. Although nesting typically in the ground, this species on occasion builds nests in many other situations, hollow trees being a favourite site, and I have noticed many nests in hollow trees in our park, some at a height of more than 40 feet from the ground. Last year I found five in oak and three in elm trees. Nesting is not restricted to the trunks, hollow branches being sometimes used, though in these cases the shape of the comb departs widely from the usual, since the wasps have to accommodate the combs to the space available, with the result that strange shapes are sometimes produced.

I have often seen nests in old roofs hanging from rafters, and such nests sometimes attain a great size, larger than ground nests, since there is little or no restriction on the space available. The largest nest I have ever seen was in such a situation. It is worth noting with regard to nests in hollow trees that in 1935 the hornet, *Vespa crabro*, and *V. vulgaris* nested in the same oak tree in our park. The nests were only some 20 feet apart and in the same hollow, yet I observed no antagonism between the two nests. In passing I might state that hornets work by moonlight, and once while working a light trap for moths not far away I was forced to retire on account of their attraction to the light.

When nesting in the ground I have always found that small clumps of trees form a favourite site; river banks, hedgerows, meadows, hill sides up to 1,000 feet, all of these are common situations, indeed only really marshy ground and very hard rocky ground is generally avoided. Open spaces and rides in large woods are also favoured.

V. vulgaris is a long-lived wasp, and the nests often maintain themselves at working strength well into November. In 1935 I saw a nest which was almost as strong on 25th November as it was in September. Many of the wasps in this nest were coated with a white fungus which would in a short time kill them.

V. vulgaris builds the most beautiful nest of all the British wasps. I have a comb of a typical example taken from a nest in a river bank. The beautiful shell-like structure and delicate variegated colours are worthy of note. The colour is caused by the use of differently coloured material in successive layers,

one wasp bringing a deep yellow strip of material and joining it on to a lighter strip of other material used by a different wasp. I have had nests of both *vulgaris* and *germanica* working on my window sill in a box and have spent many interesting hours watching the process of paper making.

Rotten wood scrapings from oak and elm are favourite building materials. Grass seed is often used as can be seen under the microscope. In fact quite a variety of material is used. The outer case of the comb is very brittle and breaks away at the slightest touch.

Vespa germanica. I have read of this wasp nesting in the roofs of houses, but have not myself seen it in such a situation. At Crickhowell it is strictly a ground-building species. It avoids the shade of trees and builds its nest in the open. I have never found a nest in a wood or even beneath a small clump of trees. In my experience it favours open grassland, meadows, river banks, roadsides, sunny banks and the like situations. This avoidance of woods and shade is never departed from in this district. Whilst not so common as *Vespa vulgaris*, *V. germanica* is quite a common wasp in Breconshire. With regard to the question of distinguishing *germanica* from *vulgaris* in the field, I find no difficulty in separating these two species. A glance at the insects entering and leaving the nest is sufficient, *germanica* appearing to me much more yellow, longer and more tapering in the body, and with more of an orange tint than *vulgaris*. I understand that Hymenopterists regard the differentiation of these two species as a matter of some difficulty, but workers in the field agree that a glance at the wasps at work enables one to distinguish them if familiar with the species in life.

The comb is of a uniform, dull drab grey colour, and lacks the beautiful variegated appearance of *vulgaris*. The shape is more rounded and not so pear-shaped, but the combs of both species vary considerably in shape. *V. germanica* sometimes builds very large combs, the materials used being, I think, chiefly the scrapings off old dead spruce fir trees and posts. Vegetable fibres are also used, but I think that spruce fir scrapings form the bulk of the material in this district. On one occasion I scraped an old fir post with a knife and placed the scrapings under a microscope together with a fragment of comb. There was almost complete agreement in colour and texture. Moreover I have watched numbers of this species at work on old fir posts gathering scrapings. The wood from which the scrapings are taken is not rotten, but dead and hard. It will be noticed that an old weathered spruce trunk or post is much the same colour as the comb of *V. germanica*. The comb of this species is of a much less brittle nature than is that of *vulgaris*, and is, in fact, quite a firm and substantial structure and able to bear much more rough usage.

General habits.

I am of the opinion that when *V. vulgaris* builds in the ground in the deep shade of woods it is much more vicious and spiteful than when the nest has been built in the open. This seems so curious that I hesitate to mention it, but that I am so convinced of its truth. I can offer, however, no explanation. Not only whilst endeavouring to take a nest of this species, but even whilst engaged in observing it, I have noticed this peculiarity. On the other hand, when a nest has been built in open meadow land the species is almost never aggressive if one is quiet, and even permits the taking of a nest from such a situation without becoming so vicious as mentioned above.

V. germanica seems to me a more aggressive and nervous species than

vulgaris. On approaching close to a strong nest the wasps come buzzing round one's head in numbers, without, however, attacking if the observer remains quiet. When angered, in my opinion, *germanica* is the most vicious of all ground wasps in this country. Specimens will even follow one for a hundred yards. This habit is shared to an even greater extent by the true wasp, *Vespa sylvestris*. *V. germanica* appears to be attracted by carrion, as I have found it in numbers on dead rabbits which have been killed by foxes.

Hibernation of Queens.

In December 1935, I found no less than 68 queens of *germanica* hibernating under the bark of a fallen ash tree. They were present in threes and fours, and had crept into the cracks of the bark and were lying under it with their wings drawn down under the body. Frost was severe at the time and the wasps were covered with a white coating of rime. They were thus practically encased in frost, but, strangely, seemed none the worse for it, for they revived within a few minutes of being taken out. Although dry bark was plentiful it is strange that they were all found under wet bark. From this it would appear that hibernating queens can withstand a severe frost without harm. Moreover, the situation I speak of was so exposed that rain and snow could be driven under the loose bark.

I have never found hibernating queens of *V. vulgaris*, which is the more surprising when it is remembered that this is so much more common in the district than is *germanica*, and must be hibernating in hundreds if one could only find where.

In my opinion 68 queen wasps is an unusual occurrence, and I know of no reference to so many queens being found together. In a dead ash tree on one occasion I found 10 queens. Ash seems to be favoured by this species, as there were plenty of other trees to choose from in the neighbourhood.

Recently I found 10 queens of *V. crabro*, the hornet, hibernating in another dead ash tree. In this case they were right inside in the rotten wood, which was so dry and decayed that it could be taken up in handfuls. Some hundred yards away there had been a hornet's nest in an elm tree, and the hibernating queens were evidently the produce of that nest.

BOOK NOTICE.

A. F. SHULL, *Evolution*. pp. x + 312, text illust. McGraw-Hill Publishing Co., Ltd., London and New York, 1936, 18s. 0d.

This volume is a further contribution to the series "McGraw-Hill Publications in the Zoological Sciences" and the editor of the series is the author of the volume.

It is primarily addressed to college students and attempts to review the field of evolution as it appears to modern biologists, with the genetic bearings indicated wherever these may reasonably be assumed.

The first four chapters are devoted to the usual classes of evidence that evolution exists and the remainder to the agencies involved, with remarks on the history of evolution and on evolution itself.

THE PREY OF HOUSE LIZARDS (*HEMIDACTYLUS* SP.) IN CALCUTTA

By D. G. SEVASTOPULO, F.R.E.S.

THE following are observations on the prey of the Geckos living in the verandah of my house in Calcutta; they are not a complete record of the insects caught as I have not noted the capture of many specimens of whose identity I was uncertain. The usual method of capture is for the lizard to approach quickly to within five or six inches of its intended victim, then to move forward very slowly and stealthily for another three or four inches and finally to cover the last inch or two with a rush and seize its prey. This last rush is usually provoked by some slight movement, and I have seen lizards watch a completely motionless insect for several minutes and only seize it when it moved slightly.

All the insects mentioned below without any reference to their Order, belong to the Heterocera.

15.ix.35. A bee, *Apis mellifera indica*, on the floor below the light was approached, but as soon as the lizard saw what it was, it retreated and made no attempt to seize it.

11.x.35. *Ophiura melicerte* Drury caught and eaten.

12.x.35. *Pachyzancla licarsisalis* Wlk. eaten. The same lizard then approached a small dead Lygaeid bug that was being dragged along the floor by an ant, nosed it and retired. The lizard made no attempt to catch the ant and, in fact, seemed a little afraid of it.

13.x.35. *Uttehisa pulchella* L. on the floor, approached and sniffed at by two lizards but not eaten. One of the lizards subsequently climbed the wall and ate a small Pyralid.

21.ii.36. *Schoenobius bipunctifer* Wlk. seized and eaten.

31.iii.36. *U. pulchella* on the ceiling was chased and caught by a lizard, but was immediately dropped and continued to fly as before.

21.iv.36. An enormous cricket caught and swallowed with considerable difficulty. The legs and cerci remained sticking out of the lizard's mouth for several minutes before finally disappearing.

28.iv.36. A large grasshopper (*OEDOPODINAE*), coloured pale green with yellow markings and a crimson abdomen, seized after some hesitation and swallowed with difficulty.

6.vi.36. A large Coccinellid, similar to the European *Anatis ocellata* L., sniffed at but left.

20.vi.36. *Spodoptera cilium* Guen. and *Thalassodes veraria* Guen. seized and eaten.

1.vii.36. The same lizard ate first a *S. cilium*, then a *U. pulchella* and then a second *S. cilium*.

3.vii.36. Two specimens of *Zinckenia fascialis* Cr. eaten in quick succession.

7.vii.36. *Spodoptera mauritia* Bsd. eaten and a female *Perina nuda* F. picked up with the head and thorax crushed. I did not see the attack on the latter insect but the injury could only have been inflicted by a lizard.

11.vii.36. *Egnasia ephyrodalis* Wlk. eaten.

14.vii.36. *S. mauritia*, *S. cilium*, *Plotheia celtis* Moore and two *E. ephyrodalis* eaten.

18.vii.36. A bee, *A. mellifera indica*, repeatedly flew against the wall and fell to the floor; it was stalked on each occasion by one or other of two lizards

but was never attacked. A small black cricket, about the same size as the bee, then crawled over the same spot and was immediately seized and eaten.

The mangled thorax, with the wings of one side still attached, of a female *P. nuda* was picked up under the light. Here, again, I did not see the actual attack, but I have no doubt that it had been dropped by a lizard, which had devoured the abdomen.

19.vii.36. In order to test the lizard with a prey, with which normally it would not come into contact, I placed a full fed larva of *Parasa lepida* Cr. on the wall. This larva is about an inch long, bright green in colour with a conspicuous blue dorsal and lateral stripe, and is covered with tufts of urticating bristles that sting like a nettle. To my surprise, it was immediately seized and, after being banged about, swallowed. I then offered a second larva, which met with the same fate.

As some of the above insects are unfamiliar to English entomologists, the following brief descriptions may be of help.

Lepidoptera.

ARCTIIDAE.

Utetheisa pulchella L. Fore-wing white speckled with black and crimson. Hind-wing white bordered with black. 45 mm.

LYMANTRIIDAE.

Perina nuda F.—Female white tinged with ochreous. 50 mm.

NOCTUIDAE.

Spodoptera mauritia Bsd. Fore-wing dark grey brown. Hind-wing semihyaline. 40 mm.

Spodoptera ciliam Guen. Fore-wing mottled grey brown. Hind-wing semihyaline. 30 mm.

Plotheia celtis Moore.—Fore-wing brown with a darker medial patch. Hind-wing semihyaline. 25 mm.

Ophiura melicerte Drury. Fore-wing marked with various shades of brown. Hind-wing blackish with a white band. 65 mm.

Egnasia ephyrodalis Wlk. Yellowish-brown with a discocellular hyaline crescent on each wing. 40 mm.

GEOMETRIDAE.

Thalassodes veraria Guen.—Green with white striae. 40 mm.

PYRALIDAE.

Schoenobius bipunctifer Wlk. Orange yellow with a black spot in the cell of fore-wing. 30 mm.

Zinckenia fascialis Cr. Blackish-brown with a white medial band. 25 mm.

Pachyzancla licarsisalis Wlk.—Fuscous. 25 mm.

The verandah, in which these observations were made, has cream-coloured walls and a white ceiling. Brown or green insects, that would be procryptic on bark or rock or among leaves, show up conspicuously whilst the grasshopper mentioned above and the larva of *P. lepida* might almost be considered as aposematic, although procryptic in their normal surroundings. Conversely, the normally aposematic female of *P. nuda* is here procryptic.

The eating of the various dull-coloured insects and the rejection of the bees and Coccinellid are according to expectations. The eating, however, of the conspicuous whitish female of *P. nuda* and also of one specimen of the typically aposematic *U. pulchella* seem to be noteworthy and the ineffectiveness of the urticating bristles of the *P. lepida* larva as a protection from the attacks of lizards is most remarkable.

A NOTE ON THE COURTSHIP OF TERMITES

By Professor G. D. HALE CARPENTER, F.R.E.S.

MR. E. BURTT in a letter written from the Tsetse Research Department, Singida, Tanganyika Territory, gave the following account which seems worth recording.

"30.xii.35. Two nights ago there was a swarming of a small yellow Termite. There were lots, and I was amused to see, after a few had arrived, odd ones would go careering about, dragging others after them. On examination the careerers were the females (had fatter bodies) and with their jaws dug into the hind end of her translucent body were one, two, or three males. The *latter* had already shed their wings in many cases. A strange courtship. I did not observe copulation at all."

A second letter, dated 20.iii.36, contained the following :—

"The observations I made on the incipient pairing of Termites I again repeated recently when precisely the same thing occurred; the males, often two or three, hanging on to the translucent body of the female with their mandibles, and being dragged along by her. This seems to me the inevitable procedure in the primary meeting of the sexes of these insects.

"The individuals when attached as described have often shed their wings, the latter evidently having served their purpose of bringing the sexes together."

I cannot remember that I ever saw a male hanging on to the female in this manner, but only a couple walking one behind the other, the rear one evidently bent on following every footstep of the leader.

Kofoed (1934, *Termites and Termite Control*) mentions only (p. 40)—"individuals of opposite sexes meeting one another usually arrange themselves in pairs with the female in front and the male behind, the latter following all the sudden twists and turns of the female, keeping his antennae playing on the tip of her abdomen, presumably because of the odour emitted by her." In a detailed account of preliminary antics (p. 214) nothing is said about the male definitely hanging on to the female by his mandibles.

Fuller (1915, *Ann. Natal Mus.*, 3, "Observations on some South African Termites") gives several accounts of courtship in different species, the relevant parts of which are here quoted.

On p. 336. "*Termes natalensis* Haviland. . . . The male alights, as a rule, directly on the dorsum of the female, flying to her with much precision. He rapidly aligns himself, with wings closely folded and head upward, and combs across and across from one cercus to the other the dilated apex of the abdomen of the female. During this the female sits quite still, but presently she dealates and gives evidence of restlessness; when her movements sufficiently stimulate the male, he dealates and crawls from her back. The female then moves forwards down the stem, the male close behind, with mouth organs always closely brushing the anal plates of the female."

On p. 341. "*Termes vulgaris* Haviland. . . . Ultimately the male manages to locate the female, and settles below her upon the same stem. He at once crawls up beside her and rapidly passes the mouth-parts across the region between the cerci and touching the cerci themselves. Almost simultaneously with this action both insects dealate and the female begins to crawl downwards, the male following. In this attitude the insects progress until the

female finds a site suitable for burrowing: the male never more than just keeps in touch with her."

On pp. 344-5. "*Termes incertus* Hagen. . . . The female . . . does not remain in the calling attitude indefinitely . . . she usually lowers her abdomen after a short while. . . . Directly she detects the immediate proximity of the male, and is certain that he is about to approach her, she hurries forward, and the male, catching up to her and placing his head upon the end of her abdomen, hastens along wherever she may lead. Occasionally two or even three males will follow one and the same female. . . ."

On p. 348. "*Enterma bilobatus* Haviland. . . . The females walked about continually, rapidly uplifting and lowering the whole of the abdomen, and raising the wings in unison. Presently a male would run in under the uplifted abdomen and, raising his head to its apex, seize it with all six feet: then, as the female pressed downward, he would dealate and tumble beneath her. This association achieved, the female walked with half-spread wings to the edge of the wet field, dragging the tightly clinging male with her. From here she took to flight, and, obviously burdened, soon settled down to earth. Immediately on touching the earth, the male encumbered females dealated: during the action the male released his hold on the ventral surface and climbed upon the back of his mate, placing the head upon the fifth or sixth abdominal segment and clasping with both fore and mid legs: only the hindmost pair was disengaged for walking."

It would seem that the actual penetration of the integument of the female by the mandibles of the following male carries the process one step further: this observation made by Mr. Burt seems not to have been recorded. It is to be regretted that the name of the species was not obtained.

EUPLOEINE BUTTERFLIES FEEDING AT THE BROKEN SURFACE OF A *TOURNEFORTIA* BRANCH, AND SOME DAYS LATER ON THE WITHERED LEAVES OF THE SAME BRANCH: TULAGI, SOLOMON ISLANDS, 1936, R. A. LEVER

By SIR EDWARD POULTON, F.R.S., F.R.E.S.

THE following two paragraphs are copied from a letter written to Prof. Hale Carpenter, from Tulagi, 3 March, 1936, by Mr. Lever:—

"Four *Euploea*s are sent from Tulagi where they were taken on a broken-off branch of a *Tournefortia argentea* which had been thrust diagonally through a small tree. On the obliquely broken lower end of the branch the insects were feeding with their proboscides extended (as I mentioned [see p. 96] with the bait of old flowers at Kolombangara in March and April 1935). I hope to get some photos. of this later on. The branch has a strong pith.

"9 March, 1936 Since writing last I have visited the *Tournefortia* tree again and found several male *Euploea*s on the withered leaves at the end of the same branch, the broken surface having apparently lost its attractive power as none was found near it. Those on the leaves I have put in a separate envelope. The proboscides were fully uncoiled and the time they were caught (by hand) was about 6.30 p.m."

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The four *Euploeas* on the broken surface of the branch and bearing the date 2 March, 1936, are *Euploea* (*Saphara*) *treitschkei* Boisds., ♂♀, and *E. (Salpinx) polymela* Godm. and Salv., ♂♂. This is the first record known to me of a female *Euploea* feeding at *Tournefortia* and it may be explained by the amount of fluid in a freshly broken branch with a strong pith. The later captures from the withered leaves were, on March 8—*Euploea* (*S.*) *polymela*, ♂, and *E. (Mestapra) nechos* Mathew, 3 ♂♂; on March 13—one male *polymela* and two male *nechos*.

The fact that the proboscides of male *Euploeas* were fully extended when feeding on the surface of "recently dead, flaccid leaves of *Tournefortia*" was first recorded by Mr. Lever in our 1934 *Proceedings* (9:57). Two examples of this behaviour were observed in Feb. 1934, on Huleo, a small coral island south of Santa Isabel. References to the attraction of *Tournefortia* for male *Euploeas* are quoted in a footnote to the account of this observation.

The postscript (18 April) of a later letter, written by Mr. Lever to Prof. Hale Carpenter, referred to the following 9 *Euploeas* taken 3 Apr. 1936 on a *Tournefortia* tree at Halavo on the S. coast of Nggela (Florida) about 4 miles E. of Tulagi:—*polymela*, 3 ♂♂; *fraudulenta*, 4 ♂♂, 1 ♀; *nechos*, 1 ♂. The presence of a female *fraudulenta* is especially interesting.

The postscript mentioned above also reminds me of a letter written to me a year ago and unfortunately mislaid. Mr. Lever's kindness in now sending a carbon copy enables me to make late reparation by communicating the following interesting notes:—

NOTES ON *EUPLOEA* AND OTHER LEPIDOPTERA ATTRACTED TO *TOURNEFORTIA* AT KOLOMBANGARA, SOLOMON ISLANDS

By R. A. LEVER, B.Sc., F.L.S., F.R.E.S.

ON March 31st and April 1st, 1935, when staying at Karikana Estate on Kolombangara Island, which is some 15 miles in diameter, I had a good chance to repair the opportunity I missed at Huleo I., Isabel, in February twelvemonth. The bungalow where I was living was only some 10 yards from the sea, and growing along the shore line was a number of *Tournefortia argentifolia* trees which had been cut back so as to be little over a foot high. I noticed that one of these stunted shrubs was surrounded by a cloud of *Euploea*, and when I caught some in the net an even larger number of the butterflies flew from inside the foliage. Brushing this aside I found a few withered flowers and their adjacent leaves, which were brown and damp. These shoots I collected and pulled off, also some branches with fresh green leaves, and placed the flowers and withered leaves in one heap and the living branches in a heap on either side. In a few minutes the central pile was visited by up to half a dozen male *Euploeas*, which I captured and marked the papers with a cross. In addition there was a Danaid which I have not seen before with pretty yellow markings [*Danaus shencki* Koch], a species of *Danaus* and *Euchromia oenone* Butl., the latter usually in *coitu*. I did not take, or see, any *Deiopia pulchella* which was noticed by Woodford at Aru Is. (p. 193, "Naturalist Among the Head Hunters," 1890). As showing how attractive the old leaves and pieces of stem were, I may say that in making frequent sweeps with my

net I naturally scattered the heap, and the butterflies came to these fragments which were not at once noticeable in the broken-up coral ground where the leaves had been placed.

In not one instance were the lateral heaps of fresh leaves visited, in marked contrast to the old ones where the *Euploeas* and *Danaus* arrived in constant succession after the effect of my somewhat savage sweeps had subsided.

Incidentally the planter with whom I was staying referred to the central heap as the "bait," an apt name.

Again I noticed the proboscides of the butterflies and of the moth *Eachromia* stretched out imbibing some moisture from the bruised stalks, withered leaves and all but decayed flowers of the tree.

R. A. L.

The specimens on which these interesting observations were made are as follows:—

1935

31 March: 25 ♂♂ *E. (M.) fraudulent*, 14 of which were in papers marked with a cross.

1 ♂ *E. (S.) polymela*, with cross.

1 ♂ *Danaus shencki* Koch, without cross but specially mentioned on p. 95.

1 ♂ *Danaus mytilene* Feld., race *decipiens* Butl., with cross.

1 April:— 6 ♂♂ *E. (M.) fraudulent*, one only without cross.

5 ♂♂ *D. mytilene decipiens*, one only without cross.

2 April:— ♂♀ *E. (S.) treitschkei*, both worn, especially ♀; neither with cross.

3 April:— 1 ♂ *E. (M.) fraudulent*, with cross.

The female *treitschkei*, although without a cross, makes the third example of this sex appearing in these records, which appears to prove that the attraction to the withered leaves of *Tournefortia* is not entirely confined to male *Euploeas* but further specially directed observations would be welcome.

AGLAIS URTICAE (L.) ATTRACTED BY LAMPLIGHT AFTER HIBERNATION

By OSWALD H. LATTER, F.R.E.S.

Communicated by SIR EDWARD POULTON.

My friend Mr. D. F. Taylor, writing on April 4th from Aberdeenshire, states: "On April 2nd, at 9.0 p.m., G. and I were sitting by the fire reading when a large moth, as we thought, began fluttering round the lamp. I jumped up to investigate, and found the supposed moth was *V. [Aglaïs] urticae*. Of course the heat of the room had roused it from hibernation: but is it not unusual for this butterfly to fly round a lamp, and finally settle on it, just like a moth?"

Mr. Taylor's observation suggests that hibernating butterflies may be responsive positively to light (positively phototaxic) in spring when the period of hibernation is drawing to a close. It is possible that intensity of light may be a factor, in addition to the stimulus by higher temperature, in rousing these insects from winter torpor. Their behaviour in autumn, when they

seek dark places in which to rest for the winter, indicates that they are then negatively phototaxic. Such a reversal of the response at different seasons of the year differs merely in degree from that exhibited daily during their period of activity throughout the summer.

Comments by SIR EDWARD POULTON.

It is difficult to understand on the theory of phototaxis the emergence of *Nymphalis polychloros* (L.) from their hibernation at the closed end of a horizontal tunnel about 15 yards long, in northern Greece, as described by Mr. R. C. Shannon in our *Proceedings* (1936, (C) 1: 5, 6). A rising temperature after the winter, acting upon an organism which had matured during the period of seclusion and was ready to respond, seemed to offer the most probable explanation of the emergence in February of an insect which had entered the tunnel in May of the previous year.*

On the other hand, I have often seen a hibernating butterfly, evidently a *Vanessid* and probably *A. urticae*, aroused from the torpid condition and flying actively by night in a warm building during the winter, and I am confident that this has been very generally observed. I do not remember seeing any of these insects attracted to single lamps, but their flight was at the higher levels where the light was stronger than below, being nearer to the lamps hanging from the roof. There was, however, no doubt about the attraction of certain female *Nymphaline* butterflies which flew at night with the moths and fluttered round the ship's lamps during very wet weather in Bombay Harbour—a subject referred to in our 1934 *Proceedings* (9: 104). The females of *Hypolimnas misippus* (L.) were seen to be thus attracted two or three times and of *H. bolina* (L.) at least once, on the nights of 12–15 Sept. 1914. The preponderance of female butterflies after heavy rain followed by a hot spell was observed in August 1934, at Pretoria, by Mr. H. C. Kenway (*ibid.* pp. 103–4). I have been much interested to learn, in a recent letter (4 Jun. 1936) from my friend Dr. R. C. L. Perkins, that "*atalanta* used to come to light with many moths on the blackest nights with heavy rain in Olaa. Curiously enough this butterfly when I was in the islands was only on Hawaii. There was none on Maui the next island nor on any of the others!"

Dr. Perkins has since written (8 Jun. 1936): "I think the frequent coming to light of *atalanta* in Olaa was due to its being disturbed at night by the very heavy downpours. The rainfall there must have been 200 inches per annum, probably sometimes more. I know that more than once *tanmeamea* flew in to the light, also, and on one occasion (but I am not sure now that this last was in Olaa) *P. cardui*! Even in the heaviest downpours I sometimes saw the native *Deilephila* (*D. pyrias*) feeding at the nasturtium flowers, and the rain made no difference at all to the flying not only of the native Noctuids, but even of Geometers and Pyralids—*Scoparia* being in swarms on such nights. The dense forest where I collected in Olaa was largely cleared by coffee planters, I think about 1896, and when this crop failed, was entirely cleared for a big sugar plantation, which has never done much good! The noise of these downpours on the forest as some heavy cloud discharged itself on nights otherwise quiet and windless still sounds in my ears. There was only one house in Olaa when I first knew it, 15 miles from the Volcano house and 15 from the village of Hilo."

* Mr. Shannon records that the ovaries were very slightly developed in June.

AGLAIS URTICAE L. WITH SYMMETRICAL INJURIES POSSIBLY
INFLICTED BEFORE HIBERNATION. FLYING IN HOUSE. 30
MARCH, 1936, ST. HELENS, ISLE OF WIGHT

By SIR EDWARD POULTON.

THE male Small Tortoiseshell Butterfly, exhibited to the meeting, was found flying inside a window of St. Helens Cottage. The date, March 30, and the exceptionally cold spring of 1936, render it probable that the insect had passed the winter in the building, and that the rather extensive injuries to both fore-wings had been inflicted before hibernation.

FURTHER REFERENCES TO TERMITOPHILOUS TINEID LARVAE
OF THE GENUS *PASSALACTIS* MEYR.

By SIR EDWARD POULTON.

PROF. ALFRED EMERSON, of the University of Chicago, in a letter of 6 Apr. 1936, to Mr. Meyrick, in which he mentions his 1928 paper "Termites of the Belgian Congo and the Cameroon," referred to in *Proc. R.E.S.L.*, (C) 1: 22, states that his collections contain specimens of two species of a termitophilous larva evidently belonging to *Passalactis*, and in addition a third Lepidopterous termitophilous larva from the South Seas. He also points out that Silvestri in his 1920 paper, referred to in our 1936 *Proceedings* (10: 88), figures a W. African termitophilous larva under the name *Plastopolypus divisus* and on the same page gives the name *P. integer* to the larva described and figured by Trägårdh in his 1907 paper. Another paper which should have been mentioned has been kindly supplied by Fleet-Paymaster T. Bainbrigge Fletcher, viz., Wasmann, *Revue Zool. Afric.*, 1: 172-3, pl. 8, figs. 23a, b, 1911, where there is an account of an unnamed Lepidopterous larva found with *Rhinotermes putorius* Sjöst., nesting in dead wood, in the Belgian Congo. This larva, he suggests, may be the same as that named *P. divisus* by Silvestri, while *P. integer* may be the same as *Passalactis tentatrix* of Meyrick. It is to be hoped that these records will suggest further observations and, above all, attempts to breed the perfect insect, at present only successfully achieved by Dr. W. A. Lamborn.

Fleet-Paymaster T. Bainbrigge Fletcher also informs me that, after reading Trägårdh's 1907 paper, he "had many years ago in India kept a look-out for any similar Lepidopterous larvae when examining Termites' nests, but never came across any. The comb of the mound-building Termites, when freshly dug out and exposed, was very attractive to the moths of several species of *Opogona*, which feed in the comb (one has been bred in Ceylon), although I never found the larvae. I was corresponding last year with Mr. Busek, of Washington, about the systematic position of this genus (Trägårdh's species), which Silvestri (1920) named *Plastopolypus*. I thought that it might have some connection with *Opogona*."

ASSEMBLIES OF COCCINELLID BEETLES OBSERVED IN N. UGANDA
(1927) BY PROF. HALE CARPENTER AND IN BECHUANALAND
(1935) BY DR. W. A. LAMBORN

By SIR EDWARD POULTON.

THE following paragraph has been copied from a letter, written 3 Oct. 1935 at Fort Johnston, Nyasaland, by my friend Dr. W. A. Lamborn :—

"Since I last wrote I have been away in Bechuanaland for a couple of months, to make a survey for Sleeping Sickness. It was so dry and so hot in the daytime that very little insect life was to be seen, and almost the only observation of any interest that I was able to make concerned an enormous assembly of Coccinellid beetles, apparently aestivating on a solitary fig tree, devoid of leaves, perched on the summit of a very large termitarium. There were so many that one could see them at a distance of 25 yards as black patches. They were mostly in sheltered positions, on the underside of branches and between buttressing roots: all were motionless, and some that I marked were in exactly the same position when I again passed the tree some ten days later. Those that I removed did crawl but by no means actively. There were literally hundreds of thousands. I collected a couple of handfuls, which I will soon send with a covering note to the Department. I read in the *P.R.E.S.* for 5/12/34 [1935, *Proc.* 9 : 108-9] your note on such assemblages."

[The interesting details recorded below are quoted from a letter written by Dr. W. A. Lamborn, 2 Aug. 1936, at Fort Johnston :—

"As to the Coccinellids, when I was travelling last year in Bechuanaland with Mr. H. Scott-Norwebb we pitched our tents on 12th July in the neighbourhood of Sikwee on the southern bank of the Chobe River, in about 24° 10' E., 18° 55' S. I had noticed directly we got into camp a large isolated tree, devoid of leaves, standing on top of a huge termitarium about fifty yards away, and could see large black patches on it, all up the trunk and on the underside of the main limbs.

"The tree proved to be one of the Figs, and the black patches were due to enormous masses of Coccinellids, side by side, not on top of each other, all at rest and apparently hibernating, for the weather was chilly even by day, while at night it was so cold that there was ice on pools near the river. We proceeded on our journey along the river bank towards the Angola border, returning to Sikwee on the 21st of the month. I then again noticed the patches—this time from a much greater distance, of course,—and found the insects to be in exactly the same position as before (for I had put marks round some of the patches with a view to determining if they had moved). I then collected a couple of handfuls, though I could readily have filled a sack with them, for they must have been there literally in hundreds of thousands. They were at first quite inert, but started to move about a few minutes after their removal. They exuded the usual yellowish fluid with the characteristic 'Ladybird' odour when handled. I saw no evidence of attack on them by predators, and, though there was quite a carpet of the dead insects round the tree, they remained untouched by ants which were numerous in the vicinity."]

These Coccinellids, kindly determined by Mr. G. J. Arrow as *Epilachna*
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dregei Muls.* reminded me of a huge collection sent to the Hope Department in 1927 by my friend Prof. Hale Carpenter, who has written the following account of the assembly and the conditions under which it was observed :—

" July 11th, 1927.—Patiri, Gulu district, Northern Uganda. A rocky hill a few hundred feet high, with dense growth of bushes in between the tumbled boulders, was climbed. The following is an extract from my diary. 'The boulders on top, piled in the usual jumble, were absolutely covered, in places where two vertical sides faced each other, with a densely packed mass of a common dull pink Coccinellid with black network, often seen on gourd leaves. They were so closely aggregated that no rock could be seen between them, and were absolutely motionless. The total area covered must have been several yards square. I scraped off hundreds, at random, from different spots.'

" On July 12th, 1929, I visited the same spot and found the same state of affairs.

" In the northern part of Uganda the month of July falls in the middle of the wet season, or in a slight intermission between the two wet seasons of southern Uganda which tend to merge into one in the north."

These Uganda specimens, exhibited in the Library on 3 June, 1936, were studied by the late Mr. G. C. Leman, who was greatly interested in the patterns of COCCINELLIDAE, and after his death were sent with his collections to the Natural History Museum where Mr. Donisthorpe has found them mounted on cards and arranged in four boxes. Mr. Leman had evidently devoted much time to the classification of the patterns and had selected specimens as types of forms which he intended to describe. He had also submitted specimens to Dr. Sicard and recorded his identifications, viz. *Solanophila zetterstedti* Muls., *S. nigritarsis* Muls. and *S. dregei* Muls.† It is to be hoped that a Coleopterist interested in the patterns of COCCINELLIDAE will continue the work begun by Mr. Leman and add to its interest by including the results yielded by a study of the Bechuanaland collection made by Dr. Lamborn.

The migration and massing on hills of the "Sunn"-bug (*Eurygaster integriceps*) described by Dr. Hugh Scott in his Kurdistan paper (1929, *Ent. mon. Mag.*, 65: 72-3) presents an interesting similarity to the behaviour of these African Coccinellids. The *Eurygaster*, which is "one of the worst insect pests in Iraq, Syria and parts of Persia and Russia," migrates, it is believed, to the north and congregates on mountains, but also in certain well-known spots near Tehran and other cities where the insects assemble "in thousands, and are collected and destroyed by forced labour."

* R. Korschefsky in *Insek. Cat. Col. Coccinellidae*, 1, 118: 37. Berlin 1931, considers *dregei* as an ab. of *Epilachna canina* F. Sicard in 1930, *Bull. Mus. Hist. Nat.*, (2) 2: 394, places *dregei* in the genus *Solanophila*, an arrangement followed by Mr. Leman (see above).

† Mr. Arrow, who has read this proof sheet, writes that he has no doubt that these three forms are all phases of a single species. Dr. Hugh Scott also directs attention to a general reference to "massing" of COCCINELLIDAE for hibernation and in the open, in Imms, 1934, *General Text-book of Entomology*, 3rd Edn., p. 508; to the reference "gregariousness" in Subject Index of *Zool. Rec.* 1912, 1915, etc.; to Frank Cowan's mention of swarms in England in *Curiosities of Natural History*; and especially to "Le réunioni della Coccinelle," by L. Camerano, 1914, *Z. wiss. Insektenbiol.* 10: 187-9.

DRAGONFLIES AND THEIR PREY

By B. M. HOBBY, M.A., D.Phil., F.R.E.S.

THE following observations by Mr. J. J. Macbeth, of Bangkok, Siam, have been passed on to me through the kindness of Dr. K. Jordan, F.R.S., and Prof. G. D. H. Carpenter:—

“Walking along a path one day I noticed a dragonfly carrying something yellow, apparently quite out of proportion to its size and strength, as it made only a short flight and settled on a stiff stem of grass near the ground. I approached cautiously and found to my surprise that it was holding and already eating a small *Terias*. I have watched lizards catching *Appias* at a wet sand-bank, and if the grip was not a good one the lizard would make a quick dart to get under dry leaves to stop the fluttering and get a better second bite; I have seen on more than one occasion a drongo make a sudden swoop in the air and take a butterfly in its flight; but predatory as dragonflies are I never imagined they would tackle anything so large as a *Terias*, and the incident I observed is certainly unique to me.”

Unfortunately this note is without exact information as regards identifications and the date and locality where the observations were made, but it is of considerable interest inasmuch as comparatively little is known of the insect food of dragonflies, lizards and birds.

Among the butterflies recorded as prey in the literature are the Pierines, *Catopsilia catilla* (Cram.) (Aitken, 1904), *Pieris rapae* (L.) and *P. brassicae* (L.) (Speyer, 1910), *Belenois severina* (Stoll) and *Catopsilia florella* (F.) (Campion, 1914), *P. napi* (L.) (Green, 1924) and *Gonepteryx cleopatra* (L.) (Cooke, 1925), but I am unaware of any previous record of *Terias* being attacked.

The following instances of dragonflies and their prey have not previously been published. It will be noted that the list includes two further records of butterfly prey—a Satyrine and a Lycaenid. My best thanks are due to the many naturalists who have so kindly sent me material for inclusion in the bionomic collection of the Department of Entomology, Oxford University Museum, and to Mr. H. E. Edelsten, Dr. F. W. Edwards, Mr. D. E. Kimmins, Dr. O. W. Richards and Mr. N. D. Riley for kind assistance in determinations.

Aeshna grandis (L.), with *Mystacides azurea* (L.) (Trichopt., LEPTOCERIDAE), University Parks, Oxford, 23.vi.36.—E. W. Aubrook.

Agrion splendens (L.), ♂, with *Ephemera danica* L., ♂ (Ephem., EPHEMERIDAE), Sparsey Bridge, Water Eaton, Oxon, 3.vi.22.—J. Collins.

Anax imperator Leach, ♂, with *Pyrrhosoma nymphula* (Sulz.), (Odon., COENAGRIIDAE), Bagshot, Surrey, 8.vi.34.—O. W. Richards (*in litt.*).

Brachytron pratense (Müll.), ♂, with *Apis mellifera* L., ♀ (Hym., APIDAE), Wicken Fen, Cambs., 28.vi.36.—C. M. Jannings.

Id., 2 ♂♂, with *Enallagma cyathigerum* (Charp.), ♂, ♀ (Odon., COENAGRIIDAE), Wicken Fen, 28.vi.36.—J. Cowley.

Id., ♂, with *Adalia bipunctata* (L.) (Col., COCCINELLIDAE), Wicken Fen, 28.vi.36.—J. Cowley.

Coenagrion puella (L.), ♂, with *Typhlocyba ulmi* (L.) (Hem., JASSIDAE), Wicken Fen, 28.vi.36.—F. W. Edwards.

C. pulchella (V. d. Lind.), ♂, with Aphidid (Hem.), Wicken Fen, 28.vi.36.—J. Cowley.

Id., ♀, with Chironomid (Dipt.), Wicken Fen, 28.vi.36.—G. J. Kerrich.

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- Coenariid sp., with *Chironomus glaucus* Mg., ♂ (Dipt., CHIRONOMIDAE), Godstow, Oxon, 10.vi.34.—*J. Park*.
- Cordulegaster boltonii* (Don.), ♀, with *Bombus pratorum* (L.) (Hym., BOMBIDAE), ♂, Moreton Sandpit, Dorset, 22.vi.27.—*C. D. Day*.
- Id.*, ♂, with *Tabanus bromius* L., ♀ (Dipt., TABANIDAE), Slioch, Ross-shire, 4.vii.34.—*O. W. Richards*.
- Enallagma cyathigerum* (Charp.) and/or *Ischnura elegans* (V. d. Lind.) observed to take *Tettigonia viridis* L. (Hem., JASSIDAE) from vegetation at pond margin, nr. Limbar, N. Lincolnshire, 7.viii.11.—*E. A. Cockayne*. [The material preserved in the Oxford University Museum is labelled "not the actual specimens."]
- Enallagma cyathigerum* (Charp.), ♂, with *Cicrus nervosus* (L.) (Hem., DELPHACIDAE), Wicken Fen, 28.vi.36.—*J. Cowley*.
- Ischnura elegans* (V. d. Lind.), ♀, with *Symphoromyia crassicornis* (Panz.), ♂ (Dipt., LEPTIDAE), Cambridge, 26.vi.36.—*H. P. Jones*.
- Id.*, ♀, with *Mgiospila medilabanda* (F.), ♀ (Dipt., MUSCIDAE), Wicken Fen, 28.vi.36.—*J. R. Dibb*.
- Id.*, ♂, with *Ulidia erythrophthalma* Meg., ♂ (Dipt., ULIDIIDAE), Wicken Fen, 28.vi.36.—*J. Cowley*.
- Orthetrum chrysostigma* (Burm.), ♀, with *Capdo tingens* (Cram.), ♀ (Lep., LYCAENIDAE), nr. Ndala, Tanganyika, 9.i.17.—*G. D. H. Carpenter*.
- Orthetrum luzonicum* (Brauer), ♀, with *Eriocera albonotata* Lw. (Dipt., TIPULIDAE), 4000 ft., Bandarawela, Ceylon, 17.v.06.—*T. B. Fletcher*.
- O. sabina* (Drury), ♂, with *Mycalesis medus* (F.), ♂ (Lep., NYMPHALIDAE), nr. Kuching, Sarawak, 13.viii.09.—*J. C. Moulton*.
- O. trinacria* (Selys), ♂, with *Trithemis annulata* (Pal. d. Beauv.), ♂ (Odon., LIBELLULIDAE), 3200 ft., nr. Fort Johnston, Nyasaland, 28.ix.26. *W. A. Lamborn*.
- Orthetrum* sp., with *Microgrotis interstriata* (Hmps.) (Lep., NOCTUIDAE), Durban, Natal, 26.iv.19.—*C. N. Baker* (in litt., specimens in Durban Museum).
- Palaeobasis tenella* (Vill.), ♂, with *Gonomeia lateralis* (Macq.), ♂ (Dipt., TIPULIDAE), Cothill, Berks, 2.vii.36.—*G. D. H. Carpenter*.
- Pantala flavescens* (F.), ♂, "eating bodies only of winged Formicidae" (Hym.), Coimbatore, S. Central India, 17.xii.12.—*T. B. Fletcher*.
- Pyrhosoma nymphula* (Sulz.), ♀, with *Tricyphona schummeli* Edw., ♂ (Dipt., TIPULIDAE), Glen Einich, Inverness-shire, 6.vi.34.—*E. R. Goffe*.
- Id.*, 2 ♀♀, with *Tortrix musculana* (Hüb.), 2 ♂♂ (Lep., TORTRICIDAE), Abernethy Forest, Inverness-shire, 4.vi.34.—*E. R. Goffe*.

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PROLONGED LARVAL LIFE OF AN AFRICAN STRATIOMYIID

By Prof. P. A. BUXTON, F.R.E.S.

IN June 1934 my colleague, Professor J. G. Thomson, collected some dry powdery material from a rot-hole in a tree at Fort Johnston, Nyasaland, and forwarded it to London. In October of the same year the material was soaked in rain-water and next day a number of newly hatched larvae of *Aedes* were noticed, from which adults of *A. argenteus* and *simpsoni* were subsequently bred. On the same day we observed a Stratiomyiid larva about half an inch long moving about in the wet material. This was kept in a tank of water with rotten leaves and mud, at a temperature of about 80° F. (26° C.). The larva lived and grew slowly all through 1935 and until the summer of 1936, moulting four times in the period. On two occasions, owing to an oversight, the contents of the tank were allowed to become dry, but only for a few days at a time. The larva eventually pupated about 2nd July, 1936, the adult fly emerging 8 days later. My assistant, Mr. H. L. Sutton, kept careful notes and observations.

The long larval life-cycle is perhaps remarkable, particularly when it is remembered that the insect had already lived and grown before it was collected. But it should not be forgotten that the food provided may have been unsuitable, and perhaps the life-cycle under natural conditions would have been shorter. The short length of the pupal period compared with that of the larval is also remarkable. The adult fly was submitted to Dr. Lindner, and has been identified as the female of *Nyassa andreiniformis* Lind. It appears that the present specimen is the only female of the species which has yet been collected. The species was described (1934, *Deuts. ent. Z.*, **1936** : 291-316) from two males which are in the British Museum. They were collected as larvae by Dr. W. A. Lamborn in 1923 at Fort Johnston, Nyasaland, and are labelled "associated with Culicid."

THE LOSS OF WATER DURING ECDYSIS IN *RHODNIUS PROLIXUS* STÅL (HEMIPTERA)

By V. B. WIGGLESWORTH M.A., M.D., F.R.E.S.,
and J. D. GILLET, F.R.E.S.

(*London School of Hygiene and Tropical Medicine.*)

WHEN insects moult, only a small fraction of the cuticle is actually shed; the deeper parts are digested and absorbed. The digestion of the chitin and protein in the discarded cuticle is probably the main function of the moulting fluid; for although it is commonly believed to act as a lubricant during ecdysis, the moulting fluid has almost disappeared by the time this takes place. In *Rhodnius prolixus* about 86 per cent. of the cuticle of the abdomen is reabsorbed in this way (Wigglesworth, 1933); the moulting fluid and the products of digestion from the cuticle being taken in through the general surface of the body, which remains permeable to water until the process is complete. If much fluid were still present at the time of moulting, or if the new cuticle were still permeable, the insect would suffer a great loss of water by evaporation during ecdysis; whereas the whole organisation of *Rhodnius*, as in so many insects, seems to be directed towards the conservation of water. The work here described was

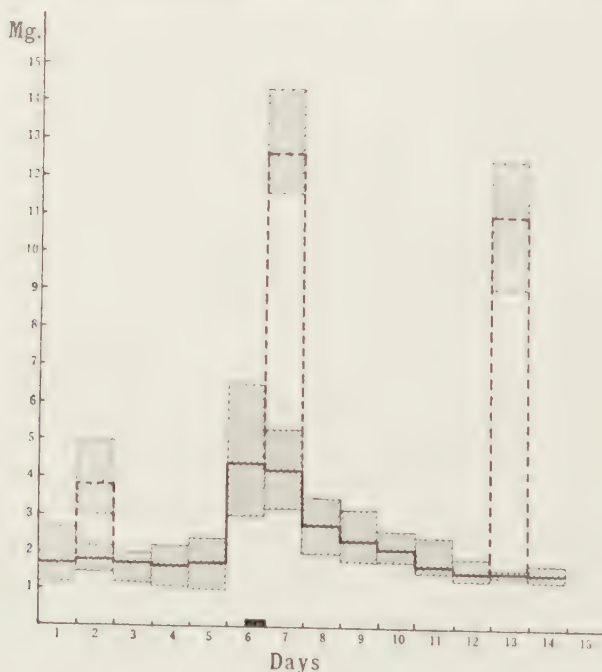


FIG. 1.—Ordinate: loss of weight in milligrams per diem. Abscissa: time in days. The thickened region of the abscissa marks the period during which moulting occurred. The continuous line shows the mean loss of weight by normal insects at 0% R.H. 24° C. The broken line shows loss of weight in 10% CO₂. The shaded areas show the extent of individual variations.

therefore undertaken to see what loss of water moulting actually entails. *Rhodnius* is well suited for such experiments because it does not normally feed during a long period before and after moulting.

It has been shown by Mellanby (1932), Gunn (1933), Koidsumi (1934) and others that, provided the insect does not excrete, loss of weight is a satisfactory measure of evaporation. The insects have therefore been weighed singly, at intervals of twenty-four hours, during their last week as 5th-stage nymphs and their first week or ten days as adults. If the insect excreted during a given day the result was discarded. In order to emphasise any differences in water loss, they were kept in desiccators over sulphuric acid (0 per cent. relative humidity; 24°C.).

Fig. 1 shows the mean loss of water in milligrams per diem over the entire period. The level for each day is the mean from a number of insects varying from 15 to 30 for different days. The weight of the cast skin has been excluded from the loss on the day of moulting: this loss represents water only. *Rhodnius* weighs about 125 mg. during the last week as a 5th instar, and about 100 mg. during the first week as an adult. The evaporation per diem in the 5th-stage nymph thus averages about 1.5 per cent. of the body weight.

The evaporation does not increase before moulting; in spite of the fact that during the last few days before the moult the old cuticle is being rapidly digested and is becoming exceedingly thin. That supports the view that the waterproof properties of the insect cuticle reside in the outermost, non-chitinous, layer—the epicuticle (Kühnelt, 1928).

On the day of moulting and the following day the loss is about doubled. The figures for these two days are very variable; for the reason that if the insect has moulted only just before weighing the loss on the day of moulting is small and on the next day large. Whereas if the insect has moulted twelve hours or more before weighing the loss on the day of moulting is much the greater. During the next four or five days the loss falls gradually and then remains constant at about 1.5 mg.

Fig. 2 shows the loss of weight in a single insect during the period from 18 hours before moulting until 12 hours after. Moulting occurred at 5 a.m. and

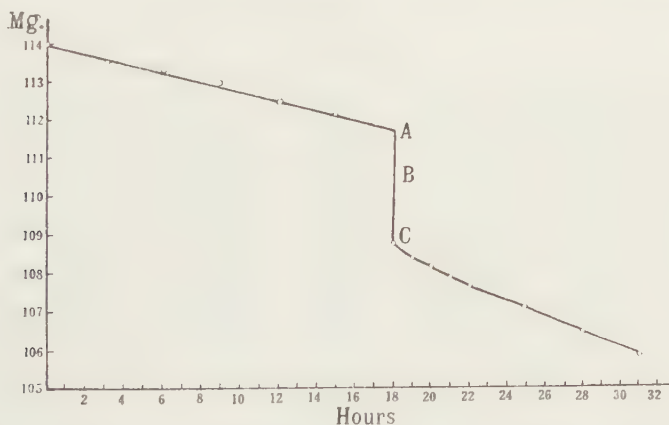


FIG. 2.—Ordinate: weight of a single insect in milligrams. Abscissa: time in hours. Moulting occurred at 18 hours from the start. B-C represents the dry weight of the cast cuticle; A-B the water lost with the cuticle.

the insect was weighed immediately afterwards; but the weight immediately before the skin was cast was deduced by extrapolation from the preceding weighings. During the act of moulting this insect, which weighed 112 mg., lost 1.8 mg. of dry matter (the old cuticle) and 1.1 mg. of water. This is a very small loss of water: it is equal to the loss over a period of about 6 hours before moulting. The increased rate of evaporation which follows moulting is shown in this figure by the steeper slope of the curve. This is most noticeable during the first hour.

It is interesting to compare the evaporation associated with moulting and the evaporation which occurs when the insect opens its spiracles. Insects normally keep the spiracles closed, opening them just enough to supply their oxygen requirements (Hazelhoff, 1927; Wigglesworth, 1935). If they are caused to keep the spiracles permanently open by exposure to air containing 5-10 per cent. of carbon dioxide, evaporation is enormously increased. This proves that the greater part of the evaporation from insects takes place through the spiracles, not through the cuticle (Mellanby, 1934).

Rhodnius nymphs before moulting, adults during the first day after moulting and adults during later days, were exposed for twenty-four hours to dry air containing 10 per cent. of carbon dioxide. The mean loss of water, based on about a dozen insects in each case, is superimposed on fig. 1. In the nymphs the evaporation is roughly doubled when the spiracles are kept open in this way; in the adults several days after moulting, evaporation is increased about seven times. This striking difference between nymphs and adults is doubtless due to the large size of the thoracic spiracles in the adult which is associated with the development of wings and flight muscles. During the first day after moulting the mean total evaporation when the spiracles are permanently open is greater by about 1.7 mg. than it is several days later. This suggests that the increased evaporation which occurs after moulting is due, at least in part, to increased loss through the cuticle. But it is possible, of course, that increased metabolism, necessitating more frequent opening of the spiracles, may be a contributory factor.

That leads to the question of the changes in the cuticle after moulting. The cuticle of the newly moulted insect is extremely soft and almost colourless. It begins to darken during the next hour or two; and eight hours after moulting

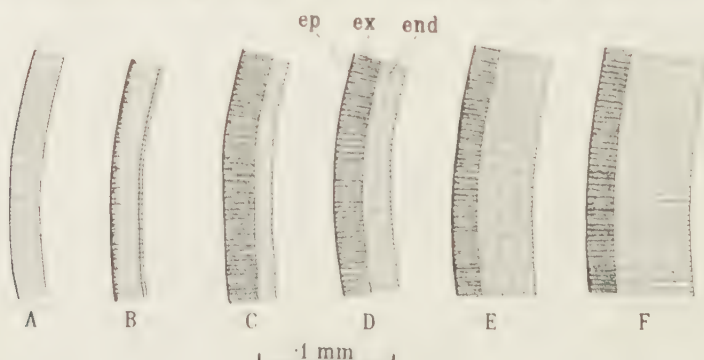


Fig. 3. Transverse sections of the cuticle in the hind part of the head of adult *Rhodnius*. The shading indicates impregnation with the amber-coloured cuticulin. A, immediately after moulting; B, 24 hours after moulting; C, 2 days; D, 4 days; E, 10 days; F, 1 month after moulting. *end*, endocuticle; *ep*, epicuticle; *ex*, exocuticle.

the development of pigment is nearly complete. But the cuticle is still soft, and it does not become fully hardened until four or five days after moulting.

Fig. 3 shows transverse sections of the cuticle in the posterior extremity of the head immediately after moulting and on succeeding days. Two changes take place. (i) At the time of moulting, the exocuticle, the part which is laid down before the old skin is shed (Wigglesworth, 1933) stains pink with eosin, and only the outermost membrane, the epicuticle, is amber-coloured and resistant to staining. After moulting, especially during the first forty-eight hours, the entire exocuticle becomes impregnated with the amber-coloured cuticulin and hence resistant to staining. (ii) The inner layer of the cuticle, the endocuticle, is laid down after moulting, so that the total thickness of the cuticle increases greatly. This process is not complete until about two weeks after ecdysis.

Koidsumi (1934), who observed a fall in the evaporation from caterpillars for several days after moulting, attributed this partly to the increasing thickness of the cuticle. But in view of the fact that the endocuticle is certainly permeable to water, we think it more probable that the progressive loss of permeability in *Rhodnius* is due to the hardening of the cuticulin in the outer layers of the cuticle. Our main conclusion, however, is that the impermeability of the cuticle is very nearly established *before* the old skin is shed, so that the extra loss of water associated with moulting is very small. As may be estimated from fig. 1, it is equivalent to what a normal insect loses in four days, or what an adult with open spiracles loses in fifteen hours.

SUMMARY.

During moulting in *Rhodnius prolixus* there is a small loss of water by evaporation; and evaporation remains slightly above the normal level for about five days. In dry air at 24° C. the total extra loss during this period is equivalent to what the normal insect loses in 15 hours when its spiracles are kept open. The smallness of this water loss is attributed to the fact that the moulting fluid is nearly all absorbed and the new cuticle is already nearly impermeable to water by the time the remnants of the old cuticle are shed.

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NOTES ON LARVIPOSITION IN *POLYBLASTUS* (HYM. ICHN. TRYPHONINAE)

By G. J. KERRICH, M.A., F.L.S., F.R.E.S.

THE genus *Polyblastus* is well known for the peculiarity that the eggs are extruded and remain in a cluster attached to the female by the stalked end, which is contained in the channel of the ovipositor: and that in this position the eggs ripen and partially hatch. Morley (1911: 289-90) has reviewed briefly the earlier observations on this subject; * and Pampel (1914) gave a description and figures of the female sexual organs and the stages of development of the chorion.

While in the majority of ICHNEUMONIDÆ the egg passes down the channel of the ovipositor, and undergoes very considerable compression and elongation in the process, which is rendered possible by the elasticity of the chorion, in the ectoparasitic genus *Tryphon* and its allies the knob or anchor at the apex of the egg-stalk alone passes down the ovipositor channel (Pampel, 1914; Bischoff, 1927), and this is the case in *Polyblastus*.

In *Tryphon* and *Dyspeles* a single egg is often to be found attached by its stalk to the ovipositor: and when handling female *Tryphon* in the field, I have several times had an egg deposited on my thumb or forefinger. Pampel (1914: 354) stated that in an egg hanging from the ovipositor of *Dyspeles* an embryo was discernible: and this observation I can confirm. According to Clausen (1932: 53) in *Tryphon incestus* Holmgr., the female may carry as many as ten eggs extruded from the body and attached to the ovipositor. I cannot recall observing more than one egg attached in this way to the ovipositor in *Tryphon*, and Clausen's observation contrasts with that of Pampel (p. 354), who stated that in species of *Tryphon* "treten nie mehrere Eier zugleich hintereinander aus dem Uterus aus, wie z. B. bei *Polyblastus*, sondern erst, wenn das am Stachel hängende Ei abgelegt ist, folgt ein weiteres nach." † But, however this may be, *Tryphon* differs from *Polyblastus* in the stage of development of the egg at the time of deposition: for Pampel stated that he had never been able to find an embryo of *Tryphon*, and Clausen stated (pp. 53-5) that in *T. incestus* the eggs are laid when the host larva is half-grown or larger, but that they normally only hatch in time for the larva to feed on the host prepupa.

After a number of unsuccessful attempts, I have been able very imperfectly to observe larviposition in *Polyblastus strobilator* Thunb. A specimen of this species and some *Dolerus* ‡ (sawfly) larvae were taken on Mäntyjoen niitty, a meadow north of (lake) Paanajärvi, Kuusamo, Finland, on August 9th, 1935. The *Polyblastus* was placed in a glass-topped tin and fed with fruit juice and sugar. Sawfly larvae were placed in the tin and developments awaited.

Observations were made intermittently over a total of some hours. During the activity of the *Polyblastus* the sawfly larvae were extremely restless, and when touched by the *Polyblastus* their wriggles were markedly more violent

* Haliday's observation that a *Polyblastus* larva attached to the female may devour its next neighbour does not seem to have been repeated, and requires confirmation. His statement that this generally happens is certainly false.

† Clausen makes no mention of Pampel's paper.

‡ Mr. R. B. Benson kindly confirmed the identity of the parasitised sawfly larvae.

than those caused by other types of disturbance. The *Polyblastus* was frequently observed to crawl on to a sawfly larva, but either crawled off or more usually was shaken off. Eggs were scraped with the hind tibiae, both as part of the normal toilet process and on separate occasions. On each of the first four days a larva was deposited during interruptions in my observations.

On August 13th four sawfly larvae were placed in the tin, and the *Polyblastus* was soon observed struggling with one that had already received two of its larvae. The process of deposition was complete in a few seconds. The egg is attached by its stalked end to the host, the "anchor" being inserted beneath the skin; and at the time of deposition, a part of the head of the parasite larva only is projecting from the egg-shell: attachment of the mouth-parts takes place later. It is, therefore, certain that the parasite larva takes no active part in its own deposition.

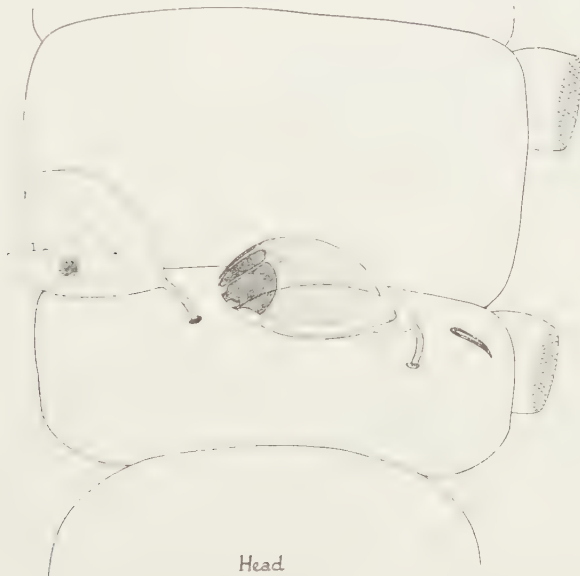


FIG. 1.—Part of head and first two thoracic segments of the sawfly larva in oblique view, showing legs of the left side and left prothoracic spiracle. Attached to the prothorax are two *Polyblastus* egg-shells: one still contains the larva; from the other the larva has been extracted; through the chorion may be seen the spot where the parasite larva has been feeding.

What is the significance of this singularity in *Polyblastus*? Morley (p. 290) suggests: "Quite possibly, in order to avoid death through the superabundance of their hosts' vitality, whole broods of these parasites are deposited at once upon the Tenthredinid host larva, and are, as Curtis occultly pronounces, nourished by the female until they arrive at a sufficiently vigorous condition to render them immune from such a contingency." Pampel (p. 355) states "... sammeln sich die Eier bei *Polyblastus* zahlreich am Stachel an, damit wahrscheinlich dem Tiere im Bedarfsfalle sofort eine grössere Menge zur Verfügung steht." Both these suggestions seem to me rather obscure. The suggestion that the eggs, when attached to the ovipositor, are nourished by the female is not at all probable. Both authors considered it likely that a number of eggs were laid

in a short time: Morley envisaged the deposition of a number of eggs on the same host; while Pampel may have considered the case of a parasite finding a number of potential hosts in a small area. The fact that my specimen in captivity laid a single egg on each of five consecutive days seems to point to some other conclusion.

In the same district in Finland I found a number of *Dolerus* larvae with ectoparasitic eggs attached, perhaps of the genus *Tryphon*. One of these larvae moulted, leaving an egg containing an advanced embryo attached to its cast skin. By not depositing the egg until the larva is ready to feed, *Polyblastus* would avoid this danger for its progeny. Whether this is significant or not, the fact of late deposition of the eggs is established, and this renders simple the explanation of the habit of bearing the eggs externally. Pampel (p. 355) gave the number of eggs hanging from the ovipositor in *P. cothurnatus* Grav., as seventeen, and this mass of eggs is much too large to be contained in the uterus.

This is my first published result of an expedition to Kuusamo and Kuolajärvi, Finland, which was led by Dr. R. Krogerus. I am very much indebted to the Royal Society and the Balfour Managers for generous financial support, and to Professor J. Stanley Gardiner for much help and encouragement in connection with the expedition. It is likewise a great pleasure to thank Dr. W. H. Thorpe for a discussion that lead to ideas incorporated in this paper, and for reading my manuscript; and Dr. C. G. Lamb, who also read my manuscript.

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BOOK NOTICE.

- K. C. McKEOWN. *Spider Wonders of Australia*. pp. xiv + 270, 17 pls. 8vo. Sydney, 1936. Angus & Robertson Ltd., 6s. 0d.

This book follows closely on the model of *Insect Wonders of Australia* noticed on p. 48 of this volume and is uniform in format.

Much information on the life-history and habits of Australian Spiders is brought together for the first time in one volume.

Not only does the author deal with true Spiders, but Scorpions and Ticks are also dealt with.

It is worthy of mention that "in view of numerous enquiries" at the Australian Museum, advice is given on the treatment of spider bite. It is not generally known that in Australia this is sometimes fatal!

NESTING HABITS OF *TRYPOXYLON* (HYM. SPHEC.) FROM TRINIDAD

By D. VESEY FITZGERALD, F.R.E.S.

THE following notes and observations were made during various periods of residence in Trinidad since the end of 1931.

I have been greatly aided by Dr. O. W. Richards, who not only gave prompt determinations of the material collected, but also much helpful advice on what observations to make. Thanks are also due to Mr. F. W. Urich and Mr. A. M. Adamson, both of the Imperial College of Tropical Agriculture for reading through the manuscript.

Descriptions of all the species mentioned in this paper, many of which were new, are to be found in the recently published "American species of the genus *Trypoxylon*" (Richards, 1934).

Subsequent collecting has brought to light a number of further species, but these have not yet been determined, and this only helps to emphasise the fact that as yet probably only a fraction of the *Trypoxylon* fauna of Trinidad is known.

Trypoxylon palliditarse Saussure.

This is the largest and one of the commonest species of *Trypoxylon* found in Trinidad.

The nest is built on walls of outhouses, cellars, furniture, sheltered sides of tree-trunks, big leaves, on roots in bank crevices, and in rock cracks. It consists of mud cylinders (pl. 1, fig. 1) usually composed of four or five cells arranged end to end. Sometimes there are several such cylinders placed side by side, possibly at times the work of more than one female, or at other times there is simply one long cylinder as much as 17 inches long, according to the nature of the surface upon which the nest is built.

The female does the nest-building, each load of mud that she brings being spread out as a rib, first to one side then to the other. This method of construction causes the characteristic "herring-bone" texture, clearly shown in pl. 1.

The male keeps sentry in the nest while the female is building, but his presence is not so constant while the storing of the spider prey, also the work of the female, is in progress.

Observations were made on the life-history of a specimen from Mt. St. Benedict on the southern slopes of the northern range.

The egg, which is crescent shaped, is 3 mm. long, greenish-white in colour. It is plastered on to the abdomen of one of the stored spiders. The egg was found on the spider on 5.iv.33, by 10.iv.33 the larva was 2 cm. in length. By 11.iv.33 the spider store was finished, and the larva rested till 14.iv.33, when the cocoon was spun, and the larva then remained quiescent as a prepupa. Observations then stopped, but it is worth noting that this specimen completed its development without any subsequent attention from the parent wasps.

The cocoon is typical of this group, hard thin and brittle; it is dark brown, 18 mm. long, cylindrical, rounded at the tail end, and slightly flattened at the head end, which has a whitish fluffy crown.

The larva spins its cocoon of silk, but at the same time secretes sufficient moisture to soften a little mud from the cell wall, which is incorporated in the cocoon, causing it to become mud coloured and eventually hard. Finally the whole work is stained dark brown with the voided excreta of the larva.

Mt. St. Benedict, N. Range, 5.iv.33; Mora Forest, Valencia Rd., 3.vi.32; Maracas Valley, N. Range, 1.xi.35; Mayaro, E. Coast, 8.iv.33; San Fernando, 2.iv.33.

Trypoxylon fuscipenne Fabricius.

The nest is built plastered to a pendant root or stick, under an overhanging bank, or from aerial roots of Epiphytes, often from those growing on the Palm, *Maximiliana caribaea*. It consists of a single long cylinder clasping the support. The mud is laid on as described for the last species, but the "herring-bone" pattern is much finer and not so pronounced. A curious feature of the nest is the neatly finished ridge at the top end of the cylinder, and the gutter-like prolongation below the mouth of the cylinder along the supporting root. No doubt these are water-shedding devices which are particularly necessary for this species, since it usually nests in places more or less exposed to rain (pl. 2, fig. 1).

Though no observations have been made, it seems probable that the female does the building and storing of the nest. The male was found on guard in the nest on three occasions, twice he was watching a partly stored cell, and the other time the cell was empty.

Morne Bleu, N. Range (*Trich*); Spring Hill Est. N. Range, 28.v.33; St. Michael's Valley, N. Range, 27.xi.34; Grasparillo Rd., N. Range, 12.i.35; Wardour Est, Caura Valley, 14.i.35; Cedros, 21.xi.34.

Trypoxylon cinereum Cameron.

Mora forest, Valencia Rd., 3.vi.32.

Trypoxylon pectorale Richards.

Mora forest, Moruga, 23.x.33. Hovering in front of holes in a post.

Trypoxylon nitidum Smith.

This is one of the commonest species about houses. No nest is built, but any convenient hole is utilised, stored with spiders and plugged with mud. This wasp has been bred from nail-holes, keyholes, book-backs, old nests of *Sceliphron* spp., *Trypoxylon palliditarse*, *Polistes* spp. and *Eumenes* spp.

The cocoon is dark brown coloured, hard and brittle. It is more or less cylindrical, but the tail end is rounded and slightly swollen.

St. Augustine, 12.ii.32; St. Augustine, 22.ii.32; Guasco, 12.iii.33; Maracas Valley, 26.vii.35; Mt. St. Benedict, 4.iv.33.

Trypoxylon fitzgeraldi Richards.

This small wasp was first found in the St. Michael's Valley, but has since been noted as common throughout the northern range.

The nest is situated on rootlets hanging down from crevices and ledges in earth banks bordering bridle roads through second growth and plantation areas. It is composed of one, two or three, more rarely up to thirteen, little mud cylinders, 8 mm. long. They are placed one on top of the other along the

supporting rootlet (pl. 3, fig. 4). The texture is rough and faintly ridged. The cocoon is of silk, soft and opaque.

St. Michael's Valley, N. Range (type locality), 24.iv.33; Balandra Bay, E. Coast, 22.x.33; Maracas Bay Rd., 1.x.33; Wardour Est, Caura Valley, 14.i.35; Arima—Blanchisseuse Rd., 7.iv.35.

Trypoxylon cornigerum Cameron.

St. Augustine, 26.iv.33. The female was collecting mud pellets from the bed of a dry pool.

Trypoxylon maidli var. *bodkini* Richards.

This species is one of the commonest in Trinidad. It is certainly a gregarious nester and it also seems probable that generation after generation may at times continue building on the original nest. The nest is situated on any flat, horizontal or vertical, surface in sheltered places such as sheds, posts, beams and under bridges. It consists of an imbricate mass of cylindrical cells, arranged fanwise. The individual cylinders are 14 mm. long, slightly curved. Each has a ridged texture when first built, but the whole aggregate mass is later splashed over with streaks of mud, obscuring the individual cells (pl. 3, fig. 3). One nest from the central range was an irregular mass of 8.5 cm. greatest length, 4 cm. greatest width and 1.7 cm. thickness. Larger nests have, however, been found.

Females have been found hiding in unstored cells.

The egg is crescent-shaped, white to semi-transparent, slightly over 1 mm. long. It is plastered to the abdomen of the *last* spider to be stored in the cell. The spider prey is rammed well into the cell, and there is a small space between the last spider and the closing plug. Since the egg is placed on the last spider, the developing larva can take advantage of this space. The larva consumes every trace of the store. The cocoon is of frail, white, tissue-paper-like silk. It is formed right at the bottom of the cell, with the head end towards the plugged entrance. The pupa, before it becomes darkly pigmented, is yellow.

As is the rule with the species that do not use their voided excrement for staining the cocoon, this forms a hard plug at the bottom of the frail cocoon.

Mt. St. Benedict, 20.iv.33; Aripo Valley, 1931–35; St. Augustine, 1931–35; Nariva, Mt. Harris, and Mitán, 2.ix.33.

Trypoxylon pachygaster Richards.

This species was found associated with the mixed rain-forest vegetation on the slopes of Tucuche near the summit, at 3000 ft. The nest consists of one, or sometimes two, mud cells built on the surface of conglomerations of soil suspended by rootlets on the underside of the roof of crevices in earth banks. This situation often makes the cells all but invisible, but the wasp shows no ability to match the colour of the mud she is using to the colour of the background, and therefore cells built of light-coloured mud are frequently conspicuous against a dark-coloured background (pl. 3, figs. 1–2). The outside texture of the cell is rough and there is sometimes a suggestion of a "herring-bone" pattern. This species is certainly a solitary builder, and from the fact that not more than two cells have been found together as is seen in pl. 3, fig. 1, though several soil conglomerations under any particular crevice may be built upon, it seems that each female is inclined to build her cells scattered over a confined area.

The cocoon is cylindrical, 8 mm. \times 2 mm., hard, rough and brittle, but it is mud coloured, not being stained with excrement.

Maracas Waterfall, 7.v.33 (type locality; Tucuche, 3000 ft., 16.ix.33; Maracas Bay Rd., 1.x.33.

Trypoxylon trinidadense Richards and *T. urichi* Richards.

These two species are recorded by Richards (1934) from Trinidad, but have not been seen by me.

Trypoxylon rubrifemoratum Richards.

One female, a paratype, was taken at flowers of *Bulens* sp. growing as a cane field weed, Orange Grove Est, 6.x.33.

Trypoxylon leucarthrum Richards.

The female type specimen was taken collecting mud in an area of mixed rain-forest vegetation at Mt. Harris, 2.ix.33.

Trypoxylon manni Richards.

This is one of the commoner and certainly a gregarious species.

The nests are built in sheltered places such as over-hanging banks and eaves of thatched roofs, in forests and cocoa plantations. The cylindrical mud cells are arranged in a more or less concentric manner around a common support with the openings downwards. As many as fifty-four cells have been found forming a nest which was 3.5 cm. in diameter (pl. 3, fig. 5). The top of the nest is neatly rounded off, and the individual tubes are later obscured by splashes of mud. From the centre of the bottom there is usually a stalactite mud projection, presumably performing the function of a drip column.

Mt. St. Benedict Valley, 23.iii.33, 30.iv.33, 13.v.33; Caura valley, 1.iv.33; Mt. Harris.

Trypoxylon fabricator Smith.

This species is one of the commoner members of the genus in Trinidad.

The mud nests have been found on the underside of a variety of flat horizontal surfaces, such as rocks, branches and large leaves such as those of Mango (*Mangifera indica*). The nest consists of an aggregate of cylinders, usually slightly curved so that the entrances face downwards. The whole nest is ornamented with a flaky mud margin, and the surface immediately in the neighbourhood of the nest is usually splashed with mud. Williams gives a figure and a short note on the nest. The figure (pl. 2, figs. 2-3) shows the flaky margin wall; the individual tubes are subsequently obscured by a covering of mud. One nest examined was composed of thirty-six cells arranged three abreast, almost certainly the work of more than one female.

Mt. St. Benedict, N. Range, 6.v.33; St. Augustine, 15.xi.33.

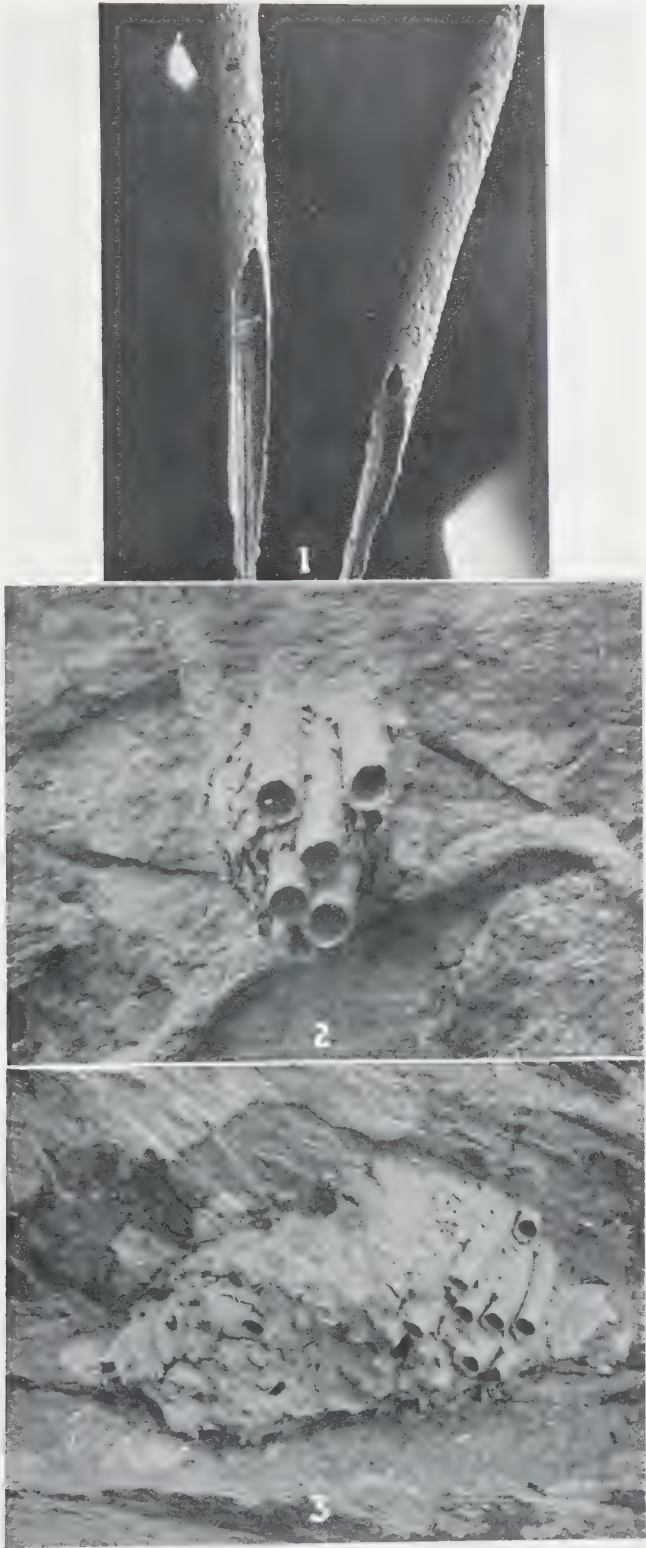
Trypoxylon cocorite Richards and *T. moraballi* Richards.

Both of these closely allied species are recorded from Trinidad by Richards (1934) from two females of the former and one female of the latter species. All three of these wasps, however, flew out from cells of the same nest. This particular nest as well as other similar, but abandoned, ones, was found on



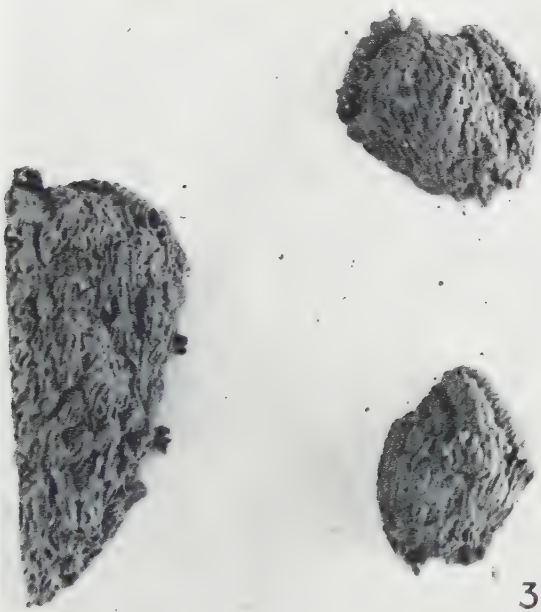
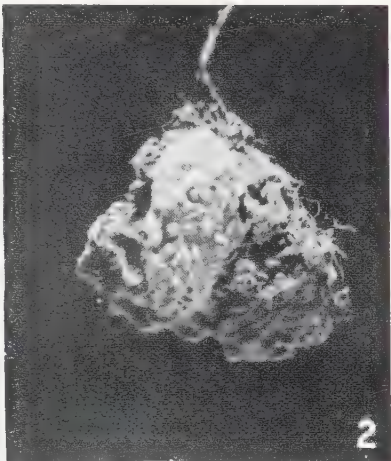
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Nest of Trypoxylon.



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Nests of *Trypoxylon*.



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the underside of the leaf base of the Cocorite palm, *Maximilliana caribaea*, growing in second-growth forest. The nest resembled that of *T. fabricator*, but the structure was more solid and the cylinders more curved.

Mt. Tabor, N. Range, 1500 ft., 13.v.33.

Trypoxylon rufidens var. *trinidadianum* Richards.

The type male of this variety was collected in rice fields bordering the Caroni River, 29.iv.33.

PLATE 1.—*Trypoxylon palliditarse* Sauss.

PLATE 2.—Fig. 1, *Trypoxylon fuscipenne* F.; figs. 2-3, *T. fabricator* Sm.

PLATE 3.—Figs. 1-2, *Trypoxylon pachygaster* Rich.; fig. 3, *T. maidli* var. *bodkini* Rich.; fig. 4, *T. fitzgeraldi* Rich.; fig. 5, *T. manni* Rich.

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THE INSECT EYE

By Dr. H. ELTRINGHAM, F.R.S., F.R.E.S.

IN a paper on the Optics of the Insect Eye by Dr. C. J. Van der Horst (1933, *Acta Zool.*, **14**), the author sought to show that the current theories of image formation, in the type of eucone eye giving an apposition image, must be incorrect.

Dr. Van der Horst points out that the pigment sleeve surrounding the cone is contracted at the apex to a diameter so small that the phenomenon of diffraction would destroy any image there formed. If this assumption were correct, the eucone eye could give no better performance than the pseudocone.

Through the good offices of Sir William Bragg, P.R.S., I have been able to submit the point to Mr. T. Smith, F.R.S., of the National Physical Laboratory. Mr. Smith has very kindly gone carefully into the matter, and is of opinion that the optical principles invoked by Dr. Van der Horst would not apply to such a structure as the eucone eye, the elements of which are in physiological continuity. After studying the structure of the eye and its supposed function, Mr. Smith has come to the conclusion that it is probably quite an efficient organ, working in the manner postulated by the current theory.

I wish to express here my indebtedness, and that of other Entomologists, to Mr. Smith, for the trouble he has taken in elucidating a very important point in insect optics.

A NOTE ON THE HIBERNATION OF *MICRASPIIS SEDECTIM-PUNCTATA* L. (VAR. 12-*PUNCTATA* L.), (COL. COCC.), AT ROTHAMSTED EXPERIMENTAL STATION

By A. C. EVANS, F.R.E.S.

(Rothamsted Experimental Station.)

INTRODUCTION.

THE presence of a large aggregation of the Ladybird *Micraspis sedecim-punctata* L. (var. 12 *punctata* L.) was brought to my notice on 6th November, 1935, by Miss M. D. Glynn of this station. Fairly regular observations on the beetles were kept during the winter and spring until dispersal occurred. By the time regular observations were commenced the numbers had reached a maximum, but Miss Glynn states that gamekeepers on the estate had noticed them, although not in quite such large numbers, about a fortnight before this time. Thus it would appear that the beetles did not come to the place of hibernation in one swarm.

SITUATION.

The aggregation occurred chiefly on one of a pair of old black (tarred) gateposts from which the gate had been removed, in the south-east corner of a field called Pastures at Rothamsted Experimental Station (25 miles north of London). On the south and east of the post is a wood and on the north and west a large field of kale and a small strip of sugar beet. Plate 1a shows the distribution of the beetles on the apical portion of the south face of the post which harboured most of them. By examining a photograph of the south face of the post under a binocular microscope it was computed that some 3-4000 were present on this side of the post, on the east face only about 120 were present, on the north about 265 and on the west about 200. Only 3 were present on the flat top of the post. Attached to the gatepost and running west is a fence of wire netting. Many thousands of beetles were present in the grass at the foot of the post and along the base of the fence for about 15 feet. Again most of the beetles were found on the south side of the fence, the grass stems frequently being completely covered from base to apex. On the other gatepost 33 beetles were present, again mostly on the south side. Another pair of gateposts 20 yards away was examined, but not a single beetle was found. The prevailing winds fluctuated between N.E. and N.W.

As the beetles were collected into variously sized groups, it is of interest to analyse the factors governing the position of the groups. The post is a rough one and has six holes bored completely through it from north to south. No beetles were found in the holes until 22nd January, 1936. Fitted against the other gatepost, on which only a few beetles were collected, is a flat iron bar, no beetles were found between this bar and the post until 27th January, 1936. Thus it would appear that the beetles did not collect in places where they would be assured of protection from inclement weather. Two factors at least appear to cause the formation of groups.

(a) The presence of an obstacle in the path of the beetles as they move up the post causes them to stop and so form a group beneath it. This is well illustrated in plate 1b, where four groups apparently formed in such a manner may be seen on the post and on its sloping support immediately below the top

strand of wire. The top edge of the post also seems to act as an obstacle, since in spite of the large numbers of beetles aggregated immediately below it, plate 1a, only 3 were present on the flat top when the photograph was taken.

(b) Some beetles remain stationary in crevices and so form obstacles below which other beetles collect, one such group is seen in the lower part of plate 1a.

The beetles were not orientated in any special way, heads pointed in all directions.

It would be interesting to determine why the beetles should aggregate so definitely on one out of four neighbouring gateposts. So far, no reason can be seen why this should be so, but the posts will be examined in the autumn of 1936 in the hope of throwing some light on this problem. On 28th March about 200 individuals were transferred to a post in a fence near the laboratory. This post is fairly new and tarred, its base being covered with stones and nettles. An examination on 30th March showed that the beetles had all dispersed, not one being found although the stones were removed during the examination. Evidently the situation was unfavourable and dispersal occurred more than a month before normal.

SEX PROPORTION.

Three samples of 50 were sexed on 18th February. The percentage of females present was 40, 38 and 32. Their ovaries were not developed.

FLUCTUATIONS IN NUMBERS ON THE SOUTH FACE OF THE POST.

According to the reports of gamekeepers the beetles increased in number between the end of October and beginning of November. It is not known when aggregation commenced, but some notes kindly given to me by Mr. C. T. Gimingham suggest that the species commences to aggregate towards the end of September. As so many beetles were present it was not practicable to obtain a numerical estimation of the fluctuations in numbers from time to time, but no large reduction in numbers occurred until the end of December, a further reduction occurred early in January. These reductions were coincident with two falls of snow. In the first case an inch of snow lay on the ground for four days and this was increased to two inches on the fifth day, in the second case two inches of snow lay for three days. The number of beetles was now reduced to just over 400, and it was decided to obtain counts of the beetles present from time to time and attempt to correlate these with weather conditions. The figures obtained, and shown graphically in fig. 1, must not be taken as representing the numbers of beetles in hibernation but rather as a rough expression of their varying activity during hibernation. During favourable conditions the beetles climbed upwards on the post and neighbouring stems of grass, but did not seem to move outwards from the base of the post to any appreciable degree. During inclement weather they apparently dropped to the ground and sheltered in the grass below. Thus hibernation for these insects does not consist of a period of complete dormancy.

An analysis of fig. 1 shows that the number of beetles present depends on temperature chiefly, there being a general correlation between the two. There are, however, certain times when a decrease in numbers is shown in spite of an increase in temperature or *vice versa*. One such instance is between 29th February and 2nd March, when in spite of an increase in temperature between these dates a reduction in numbers occurred. This reduction was probably due to a half-inch fall of snow of short duration on 1st March. On

14th March the highest number of beetles on the post was found during the period under discussion, but the temperature recorded was low. 11th March was the hottest day of the year to that date, and the temperatures of the succeeding days up to 14th March were not low enough to cause the beetles to drop off nor yet hot enough for much activity, and so it is possible that the numbers remained fairly constant until the temperature dropped still further. Sunshine and rain do not seem to have any appreciable effect. No predators were observed feeding on the beetles.

DISPERSION.

Towards the end of April the numbers of beetles on the post were greatly reduced. One cause would seem to be a slight change in habit of the beetles, quite large numbers having now moved away from the grass at the foot of the post and were to be found singly and in groups of various sizes up to a distance of three feet from the post. All these were to be found in the grass and not one on the muddy track passing between the gateposts. On 24th April the greatest activity to date was recorded, this day was also the hottest day of the year so far. On account of the change in habit referred to above the number recorded on the post for this day is not comparable with those recorded before 9th April. The following is taken from my notes recorded on the spot. "Some, very definitely not all, of the beetles are running about around and over their own group, seemingly not passing to other groups, others are running up and down or along grass or straw stems. The beetles are essentially following the example of the Duke of York who marched his men up the hill

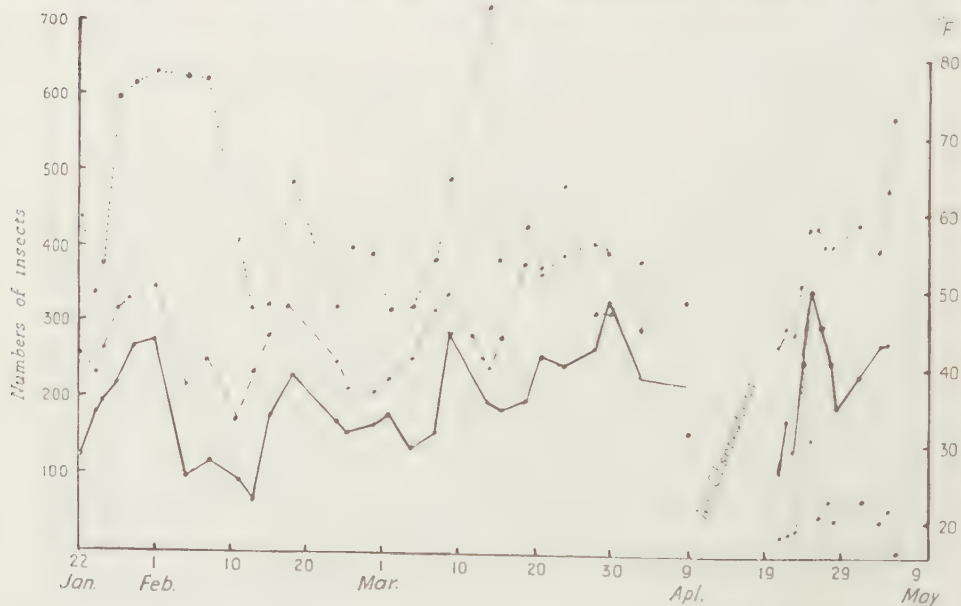
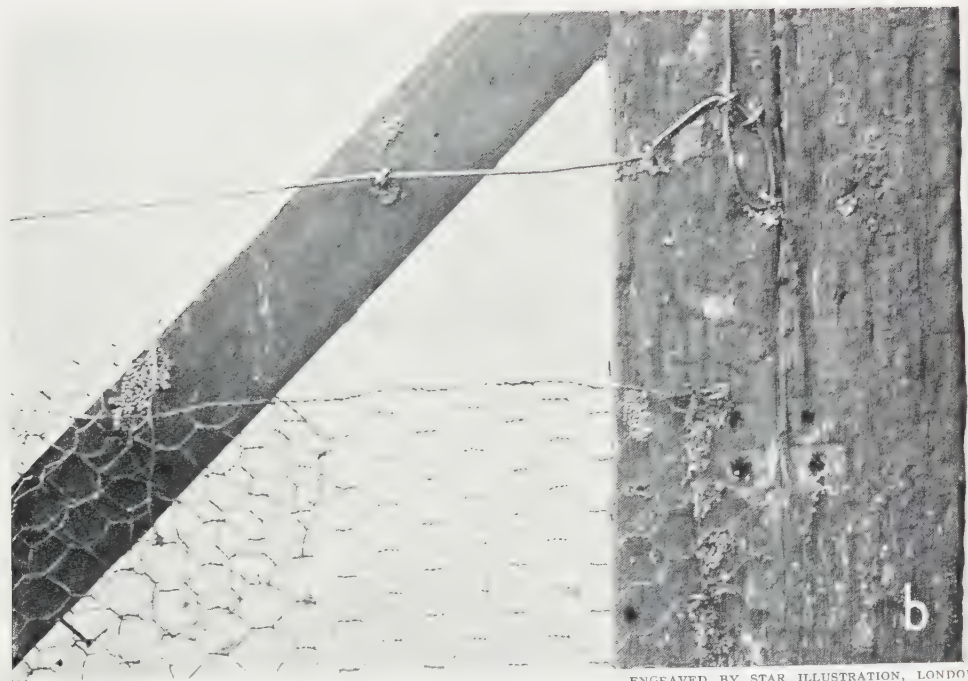
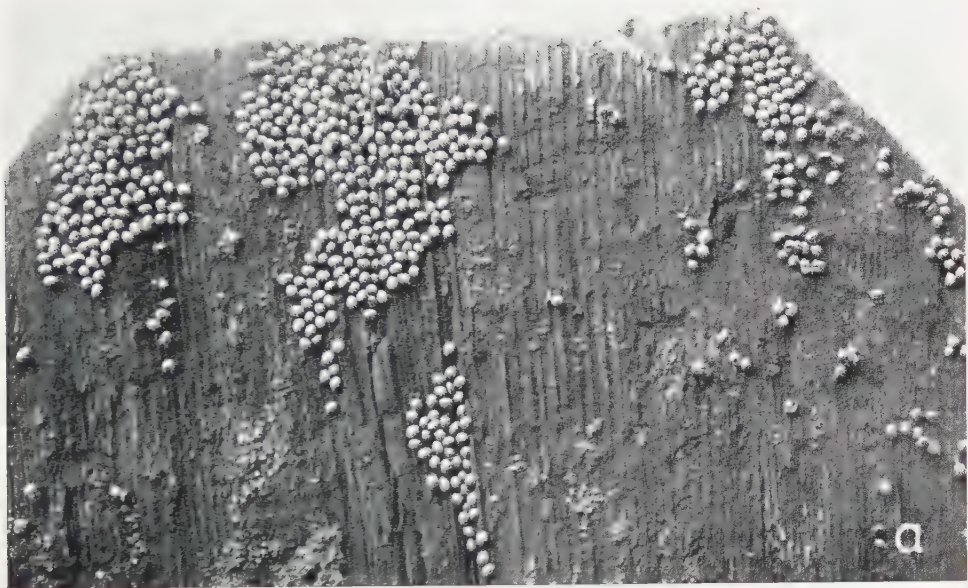


FIG. 1.—The relation between temperature and the numbers of insects on the south face of the post.

- numbers of insects,
- max. temp. of previous day,
- min. temp. of same day.



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Ladybirds hibernating on a post.

and then down again. The activity may be a prelude to dispersal, but the beetles are definitely not dispersing now. Several were thrown up into the air and a few took to flight and were promptly blown into the wood by the prevailing westerly breeze. Along the track at the bottom of Pastures two beetles were found floating with numerous flea-beetles in water in cart-tracks about 40 yards from the post. Whether these came from the post under observation or not is uncertain, they might have flown away and dropped there during a calm period or else have been blown there from another unknown group."

Dispersion actually occurred on 6th May, a day on which the temperature, 72° F., rose much higher than on any previous day during the year. Unfortunately I was away on this day and so actual details of the manner of dispersal, i.e. massed or individual flights, walking, etc., were not obtained.

Another large aggregation was known to be situated in an apiary by New Zealand field. Dispersal of this aggregation also occurred on 6th May. Dr. H. L. A. Tarr of this department was at the apiary at 3.30 p.m. (G.M.T.) and states that the number of insects present was greatly reduced by this time. Thus it would appear that the majority left earlier. On 7th May only about one-twentieth to one-hundredth of the beetles were left of the aggregation on Pastures. On 11th May numerous adults were found on flowers of dandelion, buttercup, dog's mercury and greater stitchwort.

The following notes have been kindly supplied by Mr. C. T. Gimingham :

"On 4th or 5th May, 1935, my son drew my attention to great numbers of *Micraspis* on the herbage and lower part of the hedge on the east boundary of 'Long Hoos' near the gate into 'Sawyers' [on Rothamsted Farm]. It appeared that the insects had just emerged from hibernation somewhere at the base of the hedge; they were swarming on the herbage and on the twigs and branches of the hedge, some twigs and dead stems being completely covered by them. They were densely congregated over about 2-3 ft. of the hedge, and in smaller numbers for perhaps 2 ft. on either side; many were moving about actively, but we saw none take flight. There must have been some thousands collected together.

"A few days previously, my son had seen a similar swarm near Bower Heath in the east hedge of the road from Bower Heath to the Lower Luton Road [also in Harpenden]. In this instance, the insects were less densely congregated but were spread over a greater area. I did not see them myself but had specimens for identification.

"Finally, about the third week of September 1935 (I regret that I have not the exact date; it was not earlier than the 15th nor later than the 25th) I found a small assemblage of the same species at the base of the trunk of a tree in the east hedge of 'Great Harpenden.' A pile of dry grass and other herbage had been placed against the tree and the insects were collected close together behind this, mostly on the wood. It is difficult to estimate numbers, but there were certainly several hundreds on the trunk besides many in the pile of grass. They did not move except where disturbed. This evidently did not prove a suitable spot for hibernation for about a month later all were gone."

I am indebted to Dr. C. B. Williams for helpful suggestions and to Mr. C. T. Gimingham for the details of his own observations.

PLATE 1.

Micraspis sedecimpunctata in hibernation on the south face of a post.

THE GENUS *APTINOTHRIPS* HALIDAY. FURTHER NOTES ON
THE LARVAL AND PUPAL STAGES (THYSANOPTERA:
TEREBRANTIA)

By E. R. SPEYER, M.A., F.R.E.S.

(Entomologist, Experimental Station, Cheshunt, Herts.)

SOME account of the genus *Aptinothrips* and its known species was given in 1935, *Trans. R. ent. Soc. Lond.*, **83** : 483-508. Since publication of this paper, it has been possible to examine, after remounting in Faure's medium, further material of the young stages of *A. rufus* (Gmel.) Hal., and *A. stylifer* Tryb., collected in Scotland by Dr. G. D. Morison.

From a study of this material, the following corrections and modifications in the brief descriptions previously given are called for.

A. rufus (Gmel.) Hal.

2nd Instar Larva. *Loc. cit.* : 505 Table I. The figures for the dorsal median pair of setae upon the 8th abdominal segment (25 μ), and for the ventral marginal pair upon the 10th abdominal segment (55 μ), should have been printed in ordinary type, as the length of these setae is not appreciably different from that of the corresponding setae in *A. stylifer* Tryb.

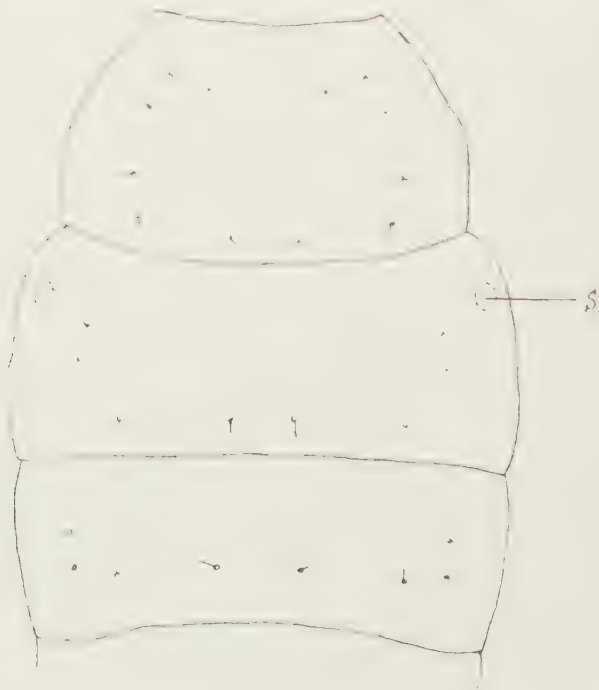


FIG. 1.—*A. rufus* (Gmel.) Hal. 1st instar larva $\times 175$. Chaetotaxy of pro- meso- and metathorax, dorsal aspect. S = mesothoracic spiracle.

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1st Instar Larva. *Loc. cit.*: 505. In addition to the differences alluded to between the chaetotaxy of the 1st and of the 2nd instar larvae of this species, differences also occur upon the *dorsal* surface of the three thoracic segments. In the 1st instar larva the number of inconspicuous setae upon the prothorax is 12, upon the mesothorax 8, and upon the metathorax 8, in dorsal aspect, as illustrated in the accompanying figure. In the 2nd instar larva, the numbers of setae are respectively 14, 12, and 10 (*loc. cit.*, figs. 21 and 22). The pair of seta-pits present upon the dorsal surface of the 8th abdominal segment of the 2nd instar larva are not represented in the 1st instar larva. Similar, or somewhat similar, differences in the general chaetotaxy of the two larval stages, are of frequent occurrence amongst the Terebrantia.

A. stylifer Trybom.

Prepupa. A single specimen, in process of changing to the pupal stage, indicates that the prepupal stage differs from that of *A. rufus* in the same manner as the 2nd instar larvae of the two species differ from one another (*loc. cit.*: 507).

In both species the dorsal surface of the 9th abdominal segment is devoid of the pair of setae and seta-pits which are represented in the pupal stage (*loc. cit.*, fig. 29a).

Pupa. The specimen referred to, *loc. cit.*: 508, of which the 8th to 11th abdominal segments in dorsal aspect are illustrated in fig. 29b, is aberrant or mutilated. Another pupa, which has since been obtained, shows that the structure of these segments is similar to that of the pupa of *A. rufus* (*loc. cit.*: fig. 29a).

The comparatively long pair of setae on the ventral surface of the mesothorax, and the comparatively long "lateral" setae on the ventral surface of the 4th abdominal segment again serve to separate the pupa of *A. stylifer* from that of *A. rufus*.

BOOK NOTICE.

R. W. DOANE, E. C. VAN DYKE, W. J. CHAMBERLAIN and H. E. BURKE, *Forest Insects. A textbook for the use of students in Forest Schools, Colleges, and Universities, and for Forest Workers.* Pp. xii + 463, text illust. 8vo. New York and London. McGraw-Hill Publishing Co., Ltd., 25s. 0d.

This book is one of the "American Forestry Series." The twelve chapters of the book deal with the importance of Forest Entomology, and the control of Forest Insects in general and in detail. Three chapters are devoted to Beetles and one each to Lepidoptera; Hymenoptera, Aphids, Scale Insects and Rhynchota; other orders and mites, and, finally, Termites.

Each chapter is completed by a bibliography and illustrated by many good illustrations which are largely original.

Two useful appendices list the soft and hard woods of America, with a list of the principal insect enemies.

As is to be expected the insects dealt with in the book are usually those of some economic importance to man. The index extends to 19 pages of double-column matter.

THE BIONOMICS OF *HYDROPSYCHE COLONICA* McL. AND *H. PHILPOTTI* TILL. (TRICHOPTERA)

By J. P. GLASGOW, M.Sc.

(Imperial College of Science and Technology.)

Communicated by Dr. O. W. RICHARDS, F.R.E.S.

Hydropsyche colonica McL.

Biology.

H. colonica is extremely common, ranging from streams such as the Avon in Christchurch (1-2 m.p.h.) up into the lower reaches of the swift mountain torrents, and is frequently amazingly abundant. In the Purau stream there were two hundred larvae to the square yard, and collecting on the banks of the Avon with a lamp in February one could easily take seventy adults in an hour and a half, during which time one would take only about thirty other caddis flies.

The biology of *H. colonica* was studied chiefly in the Purau stream, Banks' Peninsula, and to a less extent in the Poorman's stream, Nelson. The Purau stream rises on Mt. Herbert and runs down through pasture land into Lyttelton Harbour. For the last few hundred yards before it enters the sea it flows rather gently in a succession of little rapids from pools over boulders up to a foot in diameter. In summer a great quantity of loose brown slime is present, chiefly the filamentous diatom *Melosira*.

The Poorman's stream drains the west side of Jenkin's hill. Two streams descend steeply through poor forest, joining about eight hundred feet above sea-level, to wind down a gradually widening, cleared valley-plain. Half a mile below the forks the stream has much the speed of the lower reaches of the Purau stream, but the bottom is very different, consisting of broken and water-worn "slate" reduced in places to coarse grit, and nowhere larger than a foot across by three or four inches thick. In summer a thick diatomaceous slime appears, trapping a great deal of silt. The bed is not as stable as at Purau, and probably much shingle movement takes place in even moderate freshes.

The table gives a rough comparison of the faunae of the two streams. The sampling method was to mark off a square yard in the middle of a small rapid with strings stretched from the banks and lift and brush every stone within this square until the inhabited part of the stream bed was passed.

In these counts *Helicopsyche*, *Potamopygus* and the small Diptera are probably understated, as they are easily overlooked.

There is evidently in the Poorman's stream some combination of factors favouring may-flies, *Olinga*, *Hydrobiosis* and other caddis flies at the expense of *Hydropsyche*, *Helicopsyche*, Diptera and *Potamopygus*. Probably the relative impermanence of the Poorman's bed is important, and may account too for the much greater abundance of the Purau fauna.

In winter both faunae would be more numerous, for in late November many of the insects were already flying. But the population density might be lower, since owing to the rise of stream level there is considerably more bottom area available.

FAUNA OF ONE SQUARE YARD.

A. Purau . . . 28.xi.32. B. Poorman's . . . 19.xii.32.

	Number.		Per cent.	
	A.	B.	A.	B.
Trichoptera.				
<i>Hydropsyche colonica</i> larvae . . .	196	13	29	12
pupae . . .	25	9		
<i>Olinga</i> larvae	5			
pupae	34	51	7	27
empty cases	11			
<i>Helicopsyche</i>	60	—	8	—
<i>Hydrobiosis</i> larvae	12	6	3	5
pupae	10	3		
Other Rhyacophilid larvae	29	20		
Other Caddis larvae	29	7	10	15
Other Caddis pupae	16	1		
Ephemeroptera.				
<i>Deleatidium</i>	144	53	19	28
<i>Coloburiscus</i>	1	21	—	11
Neuroptera.				
<i>Archichauliodes</i>	3	1		
Plecoptera.				
<i>Stenoperla</i>	—	1		
Diptera.				
Blepharoceridae	1	—	8	—
Other Diptera	58	2		
Other Insects	5	—		
Crustacea.				
<i>Paranephrops</i>	—	1		
Gastropods.				
<i>Potamopyrgus</i>	116	1	7	
	755	190		

About a mile from its mouth the Purau stream is very different in character. The fall is much greater, and the bed strewn with large boulders between which the water pours at a great pace. Here there is never a thick growth of loose slime as there is lower down, and the fauna rather resembles that of a swift mountain torrent. *H. colonica* is less common, but there is a great increase of Blepharocerids, and the stone-fly *Stenoperla* is sometimes found.

Unlike most other caddis flies, each specimen of *H. colonica* does not build a separate case. Adhering to the lower side of a boulder is found a mass of small stones, sticks, leaves, bits of grass stem, in fact any material present in the stream, loosely held together with strands of silk, with the larvae living in the interstices. If dislodged from its shelter the larva attaches its silk thread to some object as it is swept past, and so anchors itself until it has regained a foothold. The Sericostomatid *Olinga*, which has a portable horny case, is often seen anchored in mid-stream in this way, but this has never been observed in an *H. colonica* which had not previously been disturbed. Once settled down *H. colonica* does not move from its habitation very far or very fast. On one occasion a cut about twenty yards long was made in the Poorman's stream to by-pass a meander. When this cut was visited some time after it was made, the bottom already had a thick diatomaceous covering

indistinguishable from that of the permanent stream bed, and the more active members of the fauna—may-flies and the Rhyacophilid *Hydrobiosis*—had also spread uniformly over it. But *H. colonica* was common for only about a yard down from the mouth of the cut, and the maximum distance it had moved downstream was ten yards. It had not progressed at all upstream from the lower end of the cut.

Occasionally nets are found attached to the mass of debris in which *H. colonica* lives. These nets are merely stretched across some suitable space between the substratum and some stone or piece of vegetable matter attached to it. There is never a special framework for the net such as is figured by Wesenberg-Lund, 1911, for *H. angustipennis*. The nets are probably much commoner than they appear to be, for they are always choked with diatoms and consequently invisible against the substratum once their supports are broken down.

In the upper part of the Purau stream the water pours rapidly between the great boulders. Across the gaps are built nets, commonly triangular, seldom more than an inch across the top, the larva living on its back below the net, the head and thorax on the upstream side and the abdomen on the downstream side of the net.

Although *H. colonica* never makes a special frame for the net it always uses a support of some kind. There is an undetermined species of *Hydropsyche* living in the soft papa rock at Motunau which makes little tunnels in the papa, which is about as hard as cheddar cheese, and builds across the mouth of the tunnel a small net in the shape of a segment of a cone, with the wide end, c. $\frac{3}{8}$ in. across, upstream. These nets are kept distended entirely by the pressure of the current and collapse completely when removed from the water.

The net of *H. colonica* has a square mesh of .2–.25 mm. In making the net doubled silk is used. Nets are most plentiful in summer, but are found throughout the winter also. In this respect *H. colonica* differs from the European species studied by Ussing, 1909, and Wesenberg-Lund, 1911, and from the American species studied by Noyes, 1914.

The food is mixed as in other species of *Hydropsyche*, but vegetable food predominates. A large number of guts were examined at various times throughout the year, and for a long time it was considered that the larva was entirely herbivorous, subsisting mainly on diatoms and algae, although some unidentified metaphyte remains were frequently found in the gut. In one specimen taken in June, however, the crop was full of the remains of a may-fly nymph. One can understand that *H. colonica* would rarely succeed in catching such a meal, for it is too slow to catch a may-fly in open chase, and may-flies cling to the substratum so tightly that they would seldom be carried into the nets by the current.

After the first instar the larva is indifferent to light, but is strongly thigmotropic, and prefers an inverted position. It cannot swim. Its normal movement is a slow crawl using all the legs, but it can loop quickly backwards, pulling itself along by the claws on the terminal organs. The first reaction on being disturbed is to curl up into a ball with the head and terminal organs together: it remains motionless for a few seconds, then slowly uncurls and crawls away.

When the last larval instar is mature it contracts longitudinally and is then conveniently known as the prepupa. The prepupa constructs a separate case entirely of small stones. This case is of Ulmer's "dome-shaped" type—the substratum forms the floor of the case. From above it is almost indistinguish-

able from the pupal case of *Hydrobiosis*, and it has been figured by Tillyard, 1926. The prepupa lives for a time free within this case, driving water through by dorso-ventral undulations of the abdomen. Before long it encloses itself in a silken cocoon which adheres to the sides of the case but not to the substratum. Some time later ecdysis takes place. The exuviae are found packed into the tail end of the cocoon. The duration of the pupal stadium is not known, but finally the pupa emerges from the cocoon, rises to the surface and presumably crawls out of the water before the moult.

During the day the adults shelter in the crevices in the rough bark and in the foliage of trees near the stream. At night they fly and are readily collected with a lamp. In February they first come to the light at about 20.30 (summer-time, 20.00 standard time) which is almost as soon as the lamp becomes conspicuous in the dusk. For a time they come in great numbers, but by 22.00 the "rise" is over.

The collections of adults were all made on the banks of the Avon river, Christchurch, in February 1934 and March 1935. A curious feature was the enormous preponderance of males. Of 211 adults collected on various nights only 9 were females. This could not be due to the females not being attracted to the light, for similar results were obtained by sweeping. Possibly, since none of the females taken was spent, the females die as soon as they have laid their eggs, whereas the males may live longer. One female was kept alive for six days and then died without laying her eggs. Males survived longer, the longest time being eleven days.

Evidently there is considerable variation in the length of adult life of Trichoptera. Tillyard, 1926, records that in the Australian Hydropsychid *Smicridea* the female seldom escapes from the water owing to the swarm of males which descend on her as soon as she emerges. On the other hand the Leptocerid *Notanatalica cephalotus* is viviparous, which implies a considerable length of life, for the eggs of *H. colonica* at least take over sixteen days to hatch. In *H. colonica* the female lives for some time, for the ovaries are much smaller in a newly emerged specimen than they are later, but probably, as stated, the male lives longer.

It is not known whether or not the adult feeds. A brown amorphous mass has been found in the mid-gut sometimes, but this is present also in the pupa. The enormous crop is distended with air in the male, but in the female it is collapsed by the development of the ovaries.

The eggs are large for caddis eggs, oval, *c.* .33 \times .22 mm., and dark brown. They are laid in masses only one egg deep, kept together by a very thin layer of mucilage. The eggs lie with their long axes parallel, almost touching their neighbours both at the sides and at the ends. The egg masses are more or less circular and are found on the underside of stones in the stream. How they get there is not known, but as they are seldom found on completely submerged stones the female may crawl down and deposit them *in situ*.

Eggs have been hatched in the laboratory by keeping them in water with a little *Elodea* or other water-weed. After about a fortnight they were usually attacked by the fungus *Saprolegnia*, but often they hatched before this occurred.

The first instar swims actively and does not exhibit marked thigmotropism. It is attracted to light. Tracheal gills are absent. When newly hatched there is a little greenish yolk left in the gut. This is absorbed in a day or so, and some first instars have eaten diatoms. They have never lived more than a few days, however, and the second instar has never been reared from the first.

Growth.

From May 1932 to April 1933, Mr. D. F. Hobbs, of the New Zealand Freshwater Research Committee, collected a fortnightly series of quantitative samples of the bottom fauna of Sloven's Creek, Avoca. From this material the *Hydropsyche* larvae were sorted, dried under standard conditions on blotting-paper, and weighed. From these data the growth curve (fig. 1) was drawn. The actual weighings were reduced to the weight of 100 specimens and are plotted as points with rings round them. The curve is derived from them by means of the moving average of three. On the same chart is plotted a temperature curve from Mr. Hobbs' daily observations.

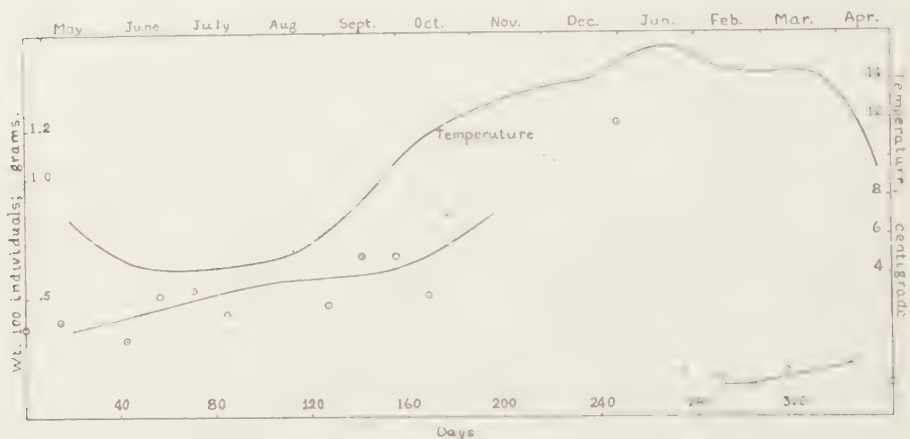


FIG. 1.—Growth of *H. colonica*.

The most interesting feature of the growth curve is the almost flat portion in late August and early September. This cessation of growth has apparently no direct connection with the temperature, as the lowest temperature is in June and July when growth is still proceeding, and in August and September the temperature is rising rapidly. Possibly there is a correlation between diatom growth and growth of *Hydropsyche*. At the end of October there is a break in the observations, as for some reason the samples from then till the end of December contained no, or only one, *Hydropsyche* larvae, but the sample at the end of December contained seven. This is a very small number, but as the weight lay in the general path of the curve it was included, as giving some indication of the weight of the fully grown larva. The curve begins again lower down, representing the newly hatched generation.

A point of interest suggested by these samples is that in the region under consideration the larva migrates before pupating, for only one pupa was taken in these samples, which were all taken from an apparently uniform stream-bed.

Owing to the smallness of the samples, not very much reliance may be placed on this curve. The largest sample was only 51, and in one case, as mentioned above, a sample of 7 was used. As the samples were always taken from adjacent parts of the stream-bed, the sampler working backwards and forwards across the stream, it is possible that the flattening in August and September is due to the sampler having encountered a somewhat younger population. This might easily be enough to explain the flattening, for, in the Purau stream at least, pupae are found through four months in the summer,

and, as shown in fig. 2, there is a considerable variation in the size of the larvae.

Life History.

To determine the length of the life-cycle, measurements were taken of a fairly large representative sample (181) and a length frequency curve (fig. 2) drawn.

The larvae were killed in hot water and measured extended as fully as possible. The measurements were taken from the front edge of the head to the base of the bunch of bristles on the end of the first joint of the terminal organ. For greater accuracy proportional dividers set in the ratio 3 : 1 were used, giving readings three times the true measurements.

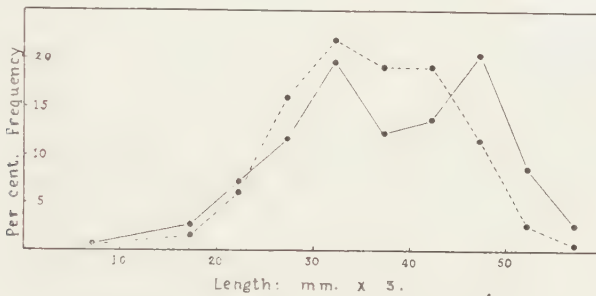


FIG. 2.—Length frequency of *H. colonica*.

The first sample measured (solid line) showed two peaks. The intervening depression was not deep enough to make it appear probable that two broods were present, but to make more certain, another sample was measured (broken line). It became clear that the life-cycle could occupy only one year, though there was a tendency toward two peaks, which might be explained through inadequate sampling, two hatchings, one in late, the other in early summer, or through a sexual difference. This is confirmed by the growth curve (fig. 1), for if there were a two-year cycle the curve would fall during the emerging season to rise again in the autumn, but there would not be a sharp break with temporary absence of larvae.

Hydropsyche philpotti Till.

H. philpotti has been found in only a few streams near Nelson; Coad's Creek on the Dun Mountain, Poorman's Creek, O'Brien's Creek, the Brook and some small steep woody streams entering the Maitai below the forks, but probably its range is greater than this. The banks of all these streams, except Coad's Creek, which lies in the barren "mineral belt," carry forest in the upper reaches where *H. philpotti* occurs. In Poorman's Creek and the Brook, which have been particularly studied, *H. philpotti* is confined to the upper reaches down to about 500 feet above sea-level. The creeks are torrential—their beds are very steep and composed of large angular blocks of "Maitai Slate" over which the water dashes in a series of waterfalls up to four feet high, with larger falls interspersed. The smaller tributaries of the Brook are so narrow that the trees almost completely close them in overhead and very little sunlight gets down to the water. *H. philpotti* is found living in much the same

formless sort of case as *H. colonica*, except that, probably because it is never as common as *H. colonica* is under favourable conditions, usually only one larva is found living in each case. A net similar to that of *colonica* is built, using whatever supports come to hand but not constructing a special frame. The mesh of the net is smaller than that of *H. colonica*, c. .1 mm. The flying season of *H. philpotti* seems to be even longer than that of *H. colonica*, for in August, when the temperature of the water was only 7° C., prepupae and pupae were quite common in the Brook. Tillyard's type specimens were collected in January.

The most important forms found associated with *H. philpotti* are Blepharocerids, Leptoperlids and may-flies, with, occasionally, *Hydrobioses* (RHYNCO-PHILIDAE), *Olinga* (SERICOSTOMATIDAE) and the stone-fly *Stenoperla*.

The streams gradually slow down further from their sources, and at about 800 feet *H. colonica* is first encountered. At first very rare, gradually it becomes the dominant form, and below 100 feet *H. philpotti* is not found at all. In this region the Poorman's stream is quite gentle and the association has been described above.

Evidently *H. philpotti* has some advantage over *H. colonica* in the torrential parts of the stream, but cannot compete with it lower down. It is interesting to find that high up in the Purau stream conditions obtain similar to those in the upper Brook and Poorman's, and here, where *H. philpotti* is absent, *H. colonica* is extremely rare.

ACKNOWLEDGEMENTS.

This work was carried out while I was at Canterbury University College, Christchurch, N.Z. I have to thank Professor E. Percival, who suggested and supervised the work, and allowed me to examine the Avoca material from which the growth curve was drawn, and also the Cawthron Institute, Nelson, for the loan of literature.

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